SCIENTIFIC AMERICAN
No. SUPPLEMENT 302

Scientific American Supplement. Vol. XII., No. 302. | NEW YORK, OCTOBER 15, 1881. | Scientific American Supplement, $5 a year.
Scientific American, established 1845. | | Scientific American and Supplement, $7 a year.

BOILER PLATE BENDING ROLLS.

THE works of Palmer's Shipbuilding and Iron Company, Limited, at Jarrow-on-Tyne, date from the year 1853, when Mr. C. W. Palmer, in conjunction with his brother, the late Mr. George Palmer, laid the foundation of the enterprise. Mr. John Price is now the general manager.

The works are situated about six miles below Tyne Bridge, and cover an area of nearly 100 acres, while they have a river frontage of about 4,000 feet.

There are three blast furnaces of the close-topped Cleveland pattern, these furnaces being 85 feet high by 24 feet in diameter at the boshes, and 8½ feet at the hearth. The make of the three furnaces is about 1,400 tons of pig per week, about three-fourths of which is used up on the works. The ore is calcined before smelting, there being a dozen kilns for this purpose, and the blast furnaces are worked with blast at a temperature of about 1,100 degrees heated in fifteen cast-iron pipe stoves. The furnaces are supplied with blast at 5 lb. pressure by a pair of "horse head" beam engines with 50-inch steam cylinder and 100-inch blowing cylinders, the stroke being 9 feet. There are also two other single engines of a similar type, but they are not now at work.

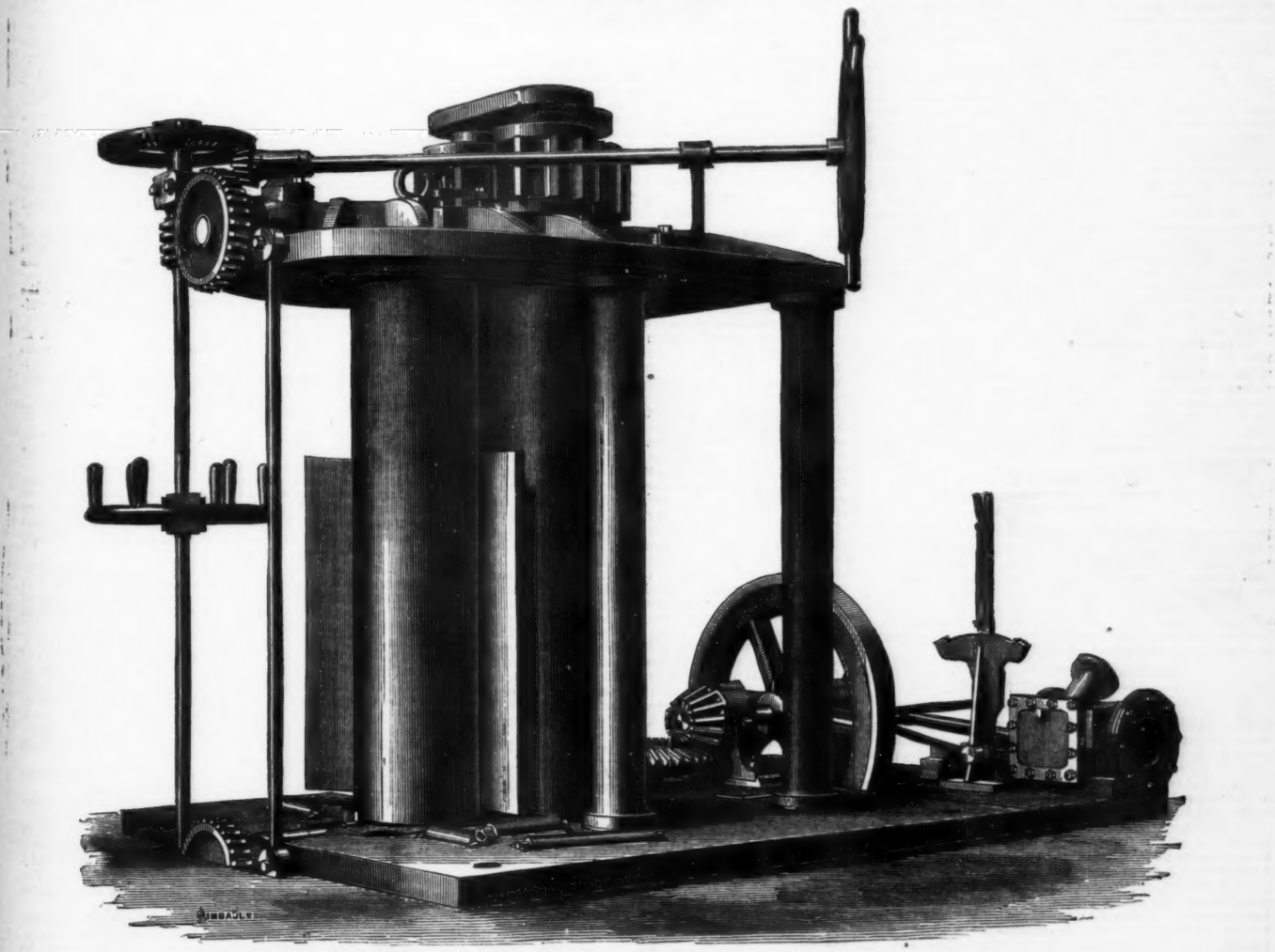
The forges, which contain 80 puddling furnaces, are capable of producing 1,000 tons of puddled bars weekly. There are two forge engines, each having a 36-inch cylinder, the stroke of one engine being 4 feet, and that of the other 5 feet; each engine drives a roll train and four pairs of 22 inch rolls. There are also two plate mills, each with two pairs of 24-inch rolls reversed by clutch and crabs, and in connection with these are ten mill furnaces, this portion of the plant being equal to turning out 1,200 tons of finished boiler and ship plates weekly. A third plate mill with four pairs of rolls and driven by an engine with a pair of 30-inch cylinders with 4 feet stroke is also capable of turning out 300 tons of plates per week. There is also a bar mill capable of producing 120 tons per week, this mill having two pairs of rolls, and being driven by an engine with 24-inch cylinder. Besides the mills already mentioned, there is also a large angle-iron and bar mill capable of rolling the largest angle-irons used in the trade, this mill being driven by a single engine with 36-inch cylinder and 4 feet stroke, while lastly there is also a sheet mill in the forge.

In connection with the rolling mill and shipyard, there is an extensive plant of circular saws, shears, punching and straightening presses, and other tools.

In the boiler-shop of this department, vertical rolls were first used for bending boiler plates, this being a mode of dealing with heavy plates which has now been extensively adopted in marine boiler works. The use of these vertical rolls suggested itself at Jarrow at a time when the firm had under consideration the question whether they should weld their boiler plates or (being manufacturers of their own iron) should roll them as long as possible. In dealing with excessively long plates by the ordinary bending rolls, a difficulty was experienced from the necessity of supporting the plates, and it was then suggested by their Mr. Gibbs that vertical rolls should be employed; such rolls enabling the plates to rest on their edges on the ground during the process of bending, and thus simplifying the whole operation. In accordance with this suggestion, a set of vertical rolls was made for the Palmer Shipbuilding and Engineering Company by Messrs. Scriven, of Leeds, and these rolls have ever since been in uninterrupted operation. We give a perspective of these rolls from which their construction will be readily understood. There are, as will be seen, three rolls, two of these being at a fixed distance apart, and geared together, while the position of the third roll is adjustable in the usual way according to the degree of curvature to be given to the plate operated upon. The arrangement for adjusting the position of the third roll is clearly shown in our engraving. The two fixed rolls are geared together not only at their upper ends, as shown, but also below the bedplate, which is level with the floor of the workshop. They are also geared below the floor level to a spur wheel on a short vertical shaft, which carries a bevel wheel at its upper end, this bevel wheel being geared into by a bevel pinion fixed on a continuation of the crankshaft of the small engine by which the machine is driven, this engine being fitted with reversing gear. In the case of the rolls at Jarrow, this engine is not employed, the rolls being driven from the main line of shafting by open and crossed belts.

In dealing with the enormous plates now used in marine boilers, the procedure at Jarrow is as follows: The plate having been planed on the edges and punched, and the lap corners planed off, is moderately heated, and is then set in the rolls to a curve marked on the floor of the shop, the arrangement of rolls enabling this be done with great facility and exactness. As the sheet plates are thus prepared, one ring is placed above the other, and the whole bolted ready to be transferred to the drill, after which it is taken to pieces and sent to the boiler-erecting shop to be finally riveted together. For riveting, Tweddell's hydraulic riveter is largely used. It is now the general practice at Jarrow to construct their marine boilers of ordinary size, with two plates only in each ring, and instead of making ordinary boilers three rings in length, they are now commencing to make them in two rings, the number of longitudinal butts being thus reduced to four instead of twelve, as formerly, while apart from the connections with the ends, there is but one circumferential seam. This is a most decided advance, but without the vertical arrangement of bending rolls it would be almost impracticable to deal with the enormous plates which the improved system of construction necessitates. These vertical bending rolls are now being adopted in nearly all the large works making marine boilers, and the arrangement is such a useful one that the fact of its having originated at the Jarrow works is well worth putting on record.

In going through this boiler shop, the visitors had a good opportunity of seeing the size to which marine boilers are now attaining, there being in progress some double-ended boilers, 16 feet 6 inches in diameter by 20 feet long, each ring being made of three plates only. These boilers are being made wholly of steel, and they are for a working pressure of 90 lb. per square inch; each boiler when finished



IMPROVED VERTICAL BOILER PLANE BENDING ROLLS.

will weigh no less than 80 tons, and the two boilers are expected to supply the steam required for indicating 3,000 horse power.—*Engineering.*

THE QUALITY OF STEAM.*

By John W. Hill, M.E.

Experience shows that steam always carries a certain percentage of water in suspension as it rises from the body of water of which it is formed. This percentage will vary as between different forms of boiler, and the same boiler operated under different conditions. The water so suspended in the steam is known as water entrained or as primage. The rising of the water in a boiler by induction, when a large steam pipe is suddenly opened, is entirely independent of the water entrained, and is not meant by any allusion to primage in this paper. I believe it is a fact observed in chemistry that anhydrous gases cannot be obtained by direct vaporization, and that a special drying process is necessary to saturate or remove the liquid always entrained in the gas upon its first formation. Saturated steam (that is, steam charged with such an amount of heat that any reduction thereof would produce condensation, and any increase thereof would produce superheat) is substantially a perfect gas, and is usually so considered in all formulæ upon its action in a steam engine.

Our best information upon the temperature (heat) of saturated steam at various pressures is from the experiments of Regnault, *C mptes Rendus*, 1847, with which all steam engineers are sufficiently familiar to avoid the description of his apparatus or the circumstances under which his experiments were made, at this time. It is proper to state, however, that the experiments of Regnault were to ascertain the relations of temperature, pressure, and density of steam; and as a corollary to determine the specific heat of steam and water at various boiling points. The determination of the relation of density and pressure was never made by Regnault, the only recorded experiments upon which were by Messrs. Fairbairn and Tate several years later.

It is now well known that the steam engine is a heat engine, that the water which is vaporized to form steam is simply a vehicle in which we store up the heat of the fuel, and which parts with a portion of this heat in transit through the engine, partly by conversion of heat into work, partly by conduction and radiation through the walls of the cylinder, and partly by the cooling effect of the atmosphere on the piston rod. No steam is expended in operating an engine; for the same weight of water as vapor which enters the cylinder by the steam pipe also leaves the cylinder by the exhaust pipe. If we deliver 1,000 pounds of steam at a given temperature to an engine through the steam ports, we shall draw off through the exhaust ports precisely the same weight of steam at a lower temperature But during the passage of this steam through the engine a certain reduction of temperature has occurred, and the efficiency of the engine is a function of the limits of temperature between which the steam enters and leaves the cylinder, as enunciated by the junior Carnot more than fifty years ago.

To illustrate the efficiency upon the heat basis, let us suppose an engine condensing—consuming—16¼ pounds of steam per hour, connected with a battery of boilers furnishing 10 pounds of steam per pound of coal from the temperature of the feed. Let the thermal value of the coal be taken at 15,500 units, and estimate 75 per cent. of this, or 11,250 units, as contained in the steam above the temperature of feed water. Then the efficiency of such an engine would be

$$100 \times \frac{11{,}250 \times 1{\cdot}65 \times 772}{33{,}000 \times 60} = 13{\cdot}82$$

per cent., or of every 100 horse-power resident in the heat expanded in working the engine less than 14 are utilized, the remaining 86 horse-power going out in the exhaust. It is well known that the best economy we have any record of has been obtained from pumping engines, and that a duty of 100,000,000 foot-pounds per 100 pounds of coal is seldom attained. Now, our condensing engine, working upon 16¼ pounds of steam, or one and sixty-five hundredths pounds of coal per hour, represents a duty of

$$\frac{33{,}000 \times 60 \times 100}{1{\cdot}65} = 119{,}988{,}000,$$

nearly 120,000,000 foot-pounds. From which it appears that about 14 per cent. is about a maximum efficiency with our present knowledge of construction. The object of this paper is, however, not to discuss the economy of steam machinery, but to show the necessity for an exact knowledge of the thermal value of steam, in estimating the economy of engine and boiler performance.

To illustrate the effect of a lack of knowledge of the quality of steam furnished by boilers, let us suppose a temperature of feed of 213° F., an expenditure of coal of 1,000 pounds, a consumption of feed-water of 12,000 pounds, and a boiler pressure by gauge of 125 pounds. The apparent evaporation from the temperature of feed in this instance is twelve pounds of steam to one of coal. Without information to the contrary, and in accordance with the usual practice, we would accept this as the evaporation and pronounce the result as extremely satisfactory. Suppose, however, the temperature of the steam, instead of being at saturation (1221·53 units), contained as a mean per pound only 1,135 units; then the actual evaporation, instead of being twelve to one, would be ten and eight-tenths to one, and this instance supposes an efficiency of furnace and boiler of nearly 75 per cent., and a thermal value of 15,000 units per pound of coal; in brief, supposes a quantity of coal and efficiency of furnace rarely obtained. None of the usual devices applied to steam boilers are capable of measuring the thermal value of steam, and recourse is had to special apparatus for this purpose. Two distinct forms of calorimeter have been used; one the continuous calorimeter, in which the condensation of a certain small percentage of the steam is maintained during the entire trial of a steam engine or boiler, and the other the intermittent calorimeter, with which at stated intervals known weights of steam are drawn from the boiler or steam pipe and condensed in known weights of water.

The continuous calorimeter consists usually of a coil of brass pipe or copper of ¼ to ½ in. diameter of bore, containing 30 to 50 lineal feet. This coil is placed within a tin can, through which the circulating water passes from below upward. The upper end of the worm is connected with the steam pipe or steam drum of the boiler, and the lower end terminates in a neck which delivers the condensed steam into a receptacle mounted upon a carefully-balanced scale, with which the condensation is weighed from time to time, and dumped. The circulating or condensing water is measured by tanks of known capacity, or through a Worthington meter, the error of which is known by test. Standing thermometers are located as follows: One in the injection pipe, by which the circulating water enters the apparatus; one in the overflow nozzle, by which the circulating water leaves the apparatus, and one in the neck of the worm from which the water of condensation flows. Should there be an indication from the calorimeter data of superheat in the steam, an additional thermometer should be inserted in the head of the worm or in the steam pipe leading to it, to measure the superheat independently and check the record of the calorimeter. Steam flows through the worm and is condensed, the heat being transferred through the walls of the coil to the circulating water. The temperature of the circulating water is elevated through a range represented by the difference of temperature of the inflow and outflow. The temperature of the condensation as it leaves the calorimeter is read from the thermometer in the neck of the worm. The temperature of the steam is the unknown quantity which we seek. To illustrate the action of the continuous calorimeter assume a weight of steam condensed of 100 pounds, a weight of circulating water expended in condensing it of 2,000 pounds, a temperature of inflow of 50° F.; a temperature of outflow of 105° F., and a temperature of condensation of 60°; then temperature of steam, neglecting small effect of variation in the specific heat, is

$$60 + \frac{2{,}000 \times 55}{100} = 1{,}160° \text{ F.}$$

Assume the steam as it entered the calorimeter, at a pressure of 135 pounds by gauge or 150 pounds absolute, at which pressure the temperature of saturation is, according to Regnault, 1,223·15 F. Then difference of temperature is 63·18 units, indicating that a portion of the water was entrained in the steam.

To estimate the percentage of primage we must bear in mind that the water in the boiler is first heated to a temperature of 362·56° F. (corresponding to a pressure by gauge of 135 pounds), before vaporization takes place; and that additional temperature of 860·2 units is necessary to vaporize the water so heated; and that the discrepancy in the thermal value of the steam applies to the temperature of vaporization, whence the water entrained as primage becomes

$$100 \times \frac{63{\cdot}18}{860{\cdot}2} = 7{\cdot}35 \text{ per cent.}$$

The intermittent calorimeter consists of a water-tight vessel (preferably of wood to avoid transfer of heat to or from the contents thereof by conduction and radiation) mounted upon a sensitive scale, into which a known weight of water is drawn. A small steam pipe, usually three quarters of an inch in diameter, closely connected with the main steam pipe or steam drum of the boiler, dips into the vessel on the scale, and is provided with a cock or open-way valve to regulate the delivery of steam into the weighed quantity of water. The temperatures are taken with a hand thermometer. As suggested, a known weight of water is first weighed into the tank on the scale, usually some convenient quantity to estimate from, as 100 or 200 pounds, of which the probable condensation in the small steam pipe usually forms a part. The amount of condensation which will collect in the steam pipe between observations will vary with the quality of steam, and must be blown out to clear the pipe before the weighed quantity of steam to be condensed is blown in. The weight of water and condensation blown out of the pipe having been justified, the temperature of the contents of the tank is carefully taken with a reliable thermometer, and 5 or 10 pounds of steam blown in and condensed. (The weight of steam condensed should be as large as consistent with a limited temperature of the contents of the tank on the scale, to obtain a high range of temperature; since errors of weight are less liable to occur than errors of temperature, and the greater the range of the mercury the smaller the effect of errors of observation.) The desired weight of steam having been condensed, the flow through the pipe is promptly suppressed and a second temperature of the contents of the tank is taken. The first temperature from the second temperature represents the range of the contents of the tank. To illustrate the principle of the intermittent calorimeter, let the following data be assumed:

Weight of condensing water	100 pounds.
Weight of steam condensed	5 "
Initial temperature condensing water	60 F.
Final temperature condensing water	115 F.
Range	55 F.

and the temperature of steam is

$$115 + \frac{100 \times 55}{5} = 1{,}228 \text{ F.}$$

Supposing steam, as before, at a pressure absolute of 150 pounds, the difference between the quality in the illustration and saturated steam is 4·82 units, corresponding to a superheat of

$$\frac{4{\cdot}82}{0{\cdot}475} = 10{\cdot}15 \text{ F.}$$

I have not detailed the construction and action of the two well-known forms of calorimeter with the expectation of adding any to your knowledge thereof, but to bring the processes fairly before you previous to calling your attention to some of the results of my experience with the instruments. I shall not attempt, in the short time which, by courtesy, you allot me, to detail all my experiments with the calorimeter, as these are many and would frequently be simple repetition results, but shall refer only to a few experiments to show the value of investigations of this class. The first results we will examine are from a series of four experiments upon boilers set with smoke-preventing furnaces for the Cincinnati Industrial Exposition for 1879.

The first case was a return tubular containing 963·64 superficial feet of heating surface, and worked at a capacity equivalent to 2·77 pounds of steam per foot of heating surface per hour, which gave a temperature of steam of 960·46 units, indicating, with a pressure by gauge of 38·75 pounds, a primage of 26·26 per cent. The apparent evaporation from the temperature of feed (70·03° F.) per pound of coal was 7·59, but the actual evaporation from same temperature was only 5·6 to one.

The second case was a return flue boiler containing 519·45 superficial feet of heating surface, and worked at a capacity equivalent to 1·78 pounds of steam per foot of heating surface per hour, which gave a temperature of steam of 864·73 units, indicating with a pressure by gauge of 80·29 pounds, a primage of 29·13 per cent. The apparent evaporation per pound of coal from the temperature of feed (166·01 F.) was 5·84, but the actual evaporation from same temperature was 4·14 to one.

The third case was a battery of 2 return tubular boilers containing 880·16 superficial feet of heating surface, and worked at a capacity equivalent to 3·20 pounds of steam per foot of heating surface per hour, which gave a temperature of steam of 1,005·93 units, indicating with a pressure by gauge of 76·18 pounds, a primage of 23·19 per cent. The apparent evaporation per pound of coal from the temperature of feed (169·11° F.) was 9·69, but the actual evaporation was 7·45 to one.

The fourth case was a direct tubular boiler containing 327·79 superficial feet of heating surface, and worked at a capacity equivalent to 2·96 pounds of steam per foot of heating surface per hour, which gave a temperature of steam of 1,441·35 units, indicating, with a pressure by gauge of 81·60 pounds, a superheat of 18·83 per cent. The apparent evaporation per pound of coal from the temperature of feed (74·55° F.) was 8·80, but the actual evaporation upon the basis of saturated steam was 10·66 to one. This boiler was set and worked simply for test purposes, and was furnished with superheating surface. The continuous calorimeter was used in these experiments. The next results to which I shall refer are the calorimeter tests for quality of steam during the trials of steam engines at the Millers' Exhibition, Cincinnati, 1880. In this instance the experiments were all made with the same boilers, operated under approximately the same conditions from day to day. The boilers, two return tubular, contained 137·24 superficial feet of heating surface, and were worked at the following capacities in pounds of steam per foot of heating surface per hour, for six different trials: 2·53, 2·42, 2·32, 2·41, 2·42, and 2·63—with corresponding temperature of steam of 1,243·84 units, 1,211·3 units, 1,315·86 units, 1,255·74 units, 1,301·65 units, and 1,313·11 units. Of these temperatures only one, the second, indicates primage; all others exhibit a slight superheat. The primage at 92·54 pounds pressure by gauge in the second experiment was 0·46 per cent. The percentage of superheat at 92·50 pounds pressure by gauge in the first experiment was 2·3; in the third experiment, with steam pressure at 91·65 pounds by gauge, 8·3 per cent.; in the fourth experiment, with steam pressure at 91·48 pounds by gauge, 3 34 per cent.; in the fifth experiment, with steam pressure at 91·44 pounds by gauge, 7·09 per cent., and in the sixth experiment, with steam pressure at 91 54 pounds by gauge, 8·06 per cent. The continuous calorimeter was used in these trials.

The former results were from four different boilers of different forms and dimensions, and operated at different steam pressures and rates of evaporation, with a range in the quality of steam from 19 per cent. of superheat to 29 per cent. of primage, while the last six results were all from the same boilers, operated at different times, under approximately the same steam pressure and rates of evaporation, with a range in the quality of steam from 8·3 per cent. of superheat to ½ per cent. of primage. From which it appears that with the same boiler or boilers, operating under similar conditions, an approximately uniform quality of steam should be had, and that the quality of steam in any one instance cannot be assured for another, unless the conditions are precisely alike.

The next results to which I shall refer are from three different trials upon the same boilers, operated with similar steam pressures, and at different rates of evaporation. The boilers, two in the battery, were of the return tubular variety, containing 932·02 superficial feet of heating surface. During the first trial, steam was made at the rate of 4·60 pounds per foot of heating surface per hour, with a resultant temperature of 1,153·09 units, indicating a primage at 92·50 pounds by gauge of 7·08 per cent.

During the second trial the boilers were worked at an evaporation equivalent to 2·86 pounds of steam per foot of heating surface per hour, with a temperature of steam of 1,199·04 units, indicating, with a pressure of 92·95 pounds by gauge, a primage of 1·92 per cent.

During the third trial the boilers were worked at a rate of evaporation equivalent to 2·90 pounds of steam per foot of heating surface per hour, with a temperature of steam of 1,174·17 units, indicating, at a gauge pressure of 92 28 pounds, a primage of 4·75 per cent. These experiments were made with an intermittent calorimeter. In all experiments exhibiting a small primage in the steam, as a superheat, the boilers were set to expose more or less of the steam room to contact with the hot gas.

The next results are from a series of three experiments with a small locomotive boiler, operated standing.

For the first trial the heating surface was 2·8 75 superficial feet, and ratio of heating to grate surface 25·90 to one. The boiler was worked at a capacity equivalent to 8·49 pounds of steam per foot of heating surface per hour, with a temperature of steam of 1,150·98 units, indicating at 105·5 pounds pressure, by gauge, a primage of 5 per cent. The apparent evaporation per pound of coal was 4·45, and the actual evaporation was 4·09 to 1.

For the second and third trials the heating surface, by the introduction of a water bridge into the fire box, was increased to 300·7 superficial feet, with a ratio of heating to grate surface of 41 67 to 1. During the second trial the boiler was worked at a rate of evaporation equivalent to 9·39 pounds of steam per foot of heating surface per hour, with a temperature of steam of 1,181·76 units, indicating at 98·25 pounds pressure, by gauge, a primage of 4·33 per cent. The apparent evaporation in this case was 7·58 pounds, and the actual evaporation 7·25 pounds of steam to 1 of coal.

During the third trial the boiler was worked at a rate of evaporation equivalent to 9·77 pounds of steam per foot of heating surface per hour, with a temperature of steam of 1,259·29 units, indicating a superheat of 88·67° F., at a pressure, by gauge, of 100·7 pounds. The apparent evaporation was 6·41 pounds of steam per pound of coal, and the actual evaporation upon the basis of saturated steam was 6·65 to 1. The rate of combustion and evaporation was higher for the third trial than for the second, with a better quality of steam and a reduced economy. In these trials the coal was burned within five or six per cent. of the total weights charged, and the calorimeter results can be fairly compared without correction.

The next result to which I will refer is from the boiler of a "Rogers" engine on the Ohio and Mississippi Railroad, in a running trial from Vincennes to Seymour, made last July. The heating surface was 984·33 superficial feet, and the rate of evaporation equivalent to 9·51 pounds of steam per foot of heating surface per hour, with a temperature of steam of 1,192·11 units, indicating a primage of 3·4 per cent., at a pressure, by gauge, of 125·56 pounds. The apparent evapo-

* A paper read before the American Railway Master Mechanics' Association, at the Providence Convention, June, 1881.

ration in this instance was 3·97 pounds per pound of coal, and the actual evaporation was 3·83 to 1. The poor economy of this boiler was largely due to the high rate of coal consumption (146·25 lb. per superficial foot of grate per hour). With large grate areas and a reduced rate of combustion per superficial foot of grate per hour, the economy of locomotive boilers may be materially improved, as shown by the results obtained with the "Wooten" boiler on the Philadelphia and Reading Railroad.

I am aware that some of my professional friends are not seized of my faith in the reliability of calorimeter results, but I am unable to obtain from them any better objection than that some modifying data have been overlooked or neglected in those cases which do not meet their approbation. However, when they agree, as they invariably do, that condensed steam and condensing water may be accurately weighed, and that approximately accurate temperatures may be had with good makes of thermometers, then I can conceive no other objections to accepting the results of calorimeter experiments than the personal errors of observation which pervade all mechanical investigations.

If the power of steam engines is to be measured by the indicator or the less reliable dynamometer or friction brake; if the economy of boilers and engines is dependent upon the accuracy of weighing scales; if steam pressures are to be taken from spring gauges, and temperatures read from mercurial thermometers, and such results are held to be reliable for absolute and comparative effect, then the same reliability must, in simple justice, be accredited the calorimeter, for it depends solely upon correct weights and temperatures and involves no complex or uncertain quantities in the operation.

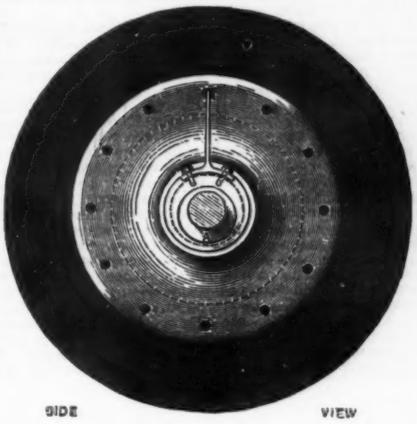
A NOVELTY IN RAILWAY CONSTRUCTION.

THE Darjeeling Tramway or Himalayan Railway is a novelty in railway construction, and will be justly regarded as one of the engineering sights of India. In his speech at the opening Sir Ashley Eden claimed for the enterprise the merit of having "solved problems never before solved in the history of railway undertakings. We know," he said, "of no other line which ascends 7,400 ft. in 50 miles, mounts gradients of 1 in 21, and comes round curves of 70 ft. radius." The line is described as presenting to the eye the appearance of "a snake winding up into the clouds." The tramway, which is 50 miles long, enables the journey from Calcutta—361 miles—to be performed in about 24 hours. Its terminus at Darjeeling is 7,690 ft. above the level of the sea. The capital of the Darjeeling Tramway Company is stated to have been raised entirely in India. The line was originally to have been completed within eighteen months, but this period has been exceeded.

The first rail was laid in May, 1879, and the contractors, Messrs. Mitchell Ramsay, succeeded in laying down the last between Jore Bungalow (7,800 ft. of elevation) and Darjeeling (about 7,400 ft.) in June last. The gauge is 2 ft. The rails are manufactured of toughened steel, and about 24,000 have been used in the construction of the entire line. Sleepers are laid at intervals of 2 ft. 8 in., extra sleepers being laid below the rail joints; altogether above 100,000 sleepers have been used up. Bearing plates have been placed under the outer rails of all curves of 120 ft. radius and under, so as to preserve the rigidity of the outer rails. Taking the entire ascent, which commences at about the ninth mile from Silliguri beyond Lukua, at the edge of the Terai, the ruling gradient is 1 ft. in 25, but in isolated steep places, the gradient is 1 in 20. From the ninth mile the line curves and recrosses the road frequently, as a rule, however, keeping to the in or hill-side of the roadway. The first distinct deviation from the ascending road occurs at a place locally known as either the Horse Shoe, the Trestle Bridge, or as Agony Point, where the line simply beetles over the edge of the *khud*, and where the trains for safety's sake slacken speed. Above Tendoria, at the nineteenth mile, the train passes through a narrow bridge and slowly describes a loop of some 640 ft. in length and then recrosses the same bridge. From the loop onward the line gradually ascends, bearing away to the right, with the *khud* below to the right of the train; while on the left rises a crumbling steep hillside, looking very threatening, with enormous bowlders of disintegrated rock, some of which have already given much trouble to the line watchers and authorities of the company. The line doubles to the leftward near Mahanuddy and its tea-garden, and then runs parallel, but in the reverse direction, above the road which the train has just traversed. The ascent continues gradually to Kurseong, some 5,200 ft. above the sea, and thence onward past some very troublesome and equally unsafe hill-sides toward Sonada. Thence on to Jore Bungalow. From Jore Bungalow the line descends from the saddle, circling round wide deviations toward Darjeeling proper, which is reached in about seven hours, run through from Silliguri, provided no landslips or other obstacles bar the way. The engines at present used are tiny tank ones, the carriages like open tramcars of the rudest and most uncomfortable description. As regards the engines, they are just like ordinary level-line locomotives trusting in the descent to very powerful brakes.

COMBINED ROAD AND RAIL TRUCK WHEELS.

IN an article on Common Road Railways, we mentioned the desirability of wagons being so constructed as to be able to run on common roads as well as upon rails. We now illustrate the wheels fitted to wagons made by Messrs. Ransomes & Rapier, Ipswich, to enable this object to be effected. This wheel, which is shown in detail, is the invention of Mr. E. Perrett, of Westminster, and the wagons or



SIDE VIEW

trucks to which they have been fitted are for use on the Dublin and Lucan steam tramway. As the line terminates some distance from the quays, the goods will be hauled by horses along the street to the terminus of the tramway, and then taken by steam to their destinations on the line, and *vice versa*. The special apparatus consists of a wheel loose on the shaft and provided with a flange, which, however, is quite separate from it and carried on its own boss; in the flange boss are two eccentrics, each of five-sixteenths of an inch throw; the inner one is fixed on to the shaft, and the outer one is prevented from turning

SECTION

by a stop. When running on the rail the two eccentrics are placed so as to neutralize each other, and the wheel and flange rotate with equal angular motion, but by turning the shaft by means of a lever, and fixing it in that position, the flange is thrown up, and revolves at a higher level than the wheel, thus enabling the wheel to run on the road. The trucks are provided with a fore carriage and pole for use when running on the ordinary road.—*The Engineer.*

NEW STEAM LINE BETWEEN NEW YORK AND FRANCE.

A NEW screw steamer—Chateau Lafitte—366 feet. 25x41·1 x30, of 3,462 tons gross, and 450 horse power, with cylinders 43-inch and 82-inch by 50-inch stroke, built by Messrs. Oswald, Mordaunt & Co., shipbuilders and engineers, Southampton, for the Compagnie Bordelaise de Navigation à Vapeur, Bordeaux, lately went on her official trial of six hours' run round the Isle of Wight, when, with a displacement of 4,400 tons, she averaged a mean speed of 12¼ knots, with a strong tide against her for the greater part of the way. On the second trial for speed on the measured mile with 1,600 tons on board, she averaged a speed of 13·6975 knots, one run being 14·063, and the other 13·333. Her engines indicated 2,687 horse power, everything working cool and satisfactorily. She is the pioneer of the new company's fleet which is intended for service between Bordeaux and New York.

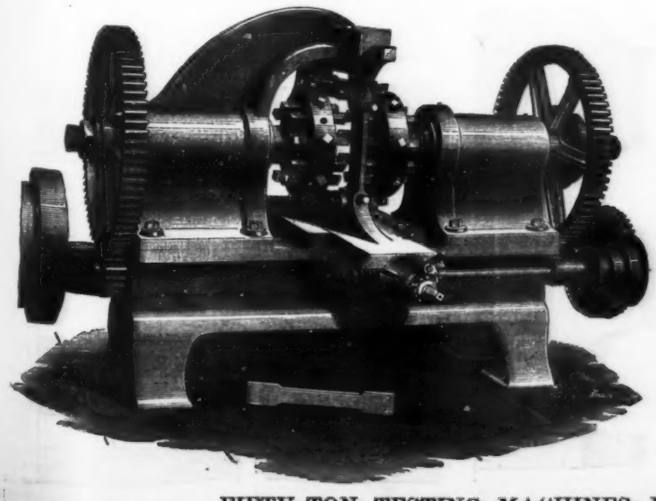
IMPROVED TESTING MACHINE.

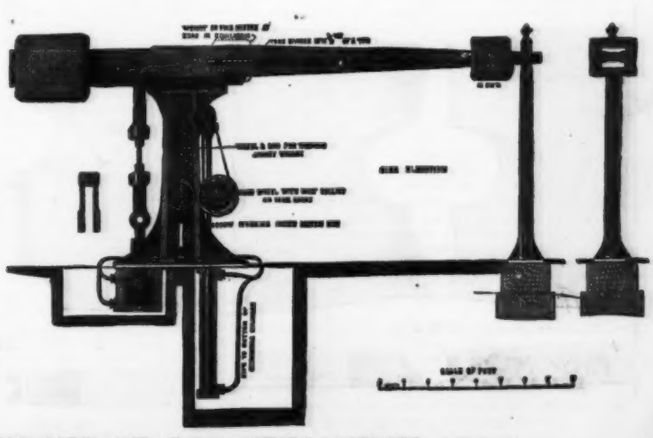
IN order to meet the increasing demand for mild steel ship and boiler plates, and also to carry out the requisite tests—tensile—specified by the Admiralty, Board of Trade, Lloyds' and Liverpool Registry, Bureau Veritas, etc., the Steel Company of Scotland found it necessary to have a machine capable of getting through a great number of tensile tests in a comparatively short time with precision and accuracy, and also to save the delay and inconvenience to which shipbuilders and boiler-makers were subjected when the materials had to be tested at their own yards.

Through the inefficiency of the hand-moved machine at the works, the machine we illustrate was designed by Mr. Thomas Williamson, works manager to the Steel Company of Scotland, and was made by Messrs. Westray, Copeland & Co., of Barrow-in-Furness. It has been in use for about two and ahalf years, and has been found to fulfill all the requirements in a satisfactory manner. The average number of tensile tests, for several months' actual work, was ninety per day of nine hours, or ten per hour, and the machine is capable of breaking one test piece every two minutes with perfectly accurate results, whence it becomes a question of measuring, checking, calculating, and reducing the strains per square inch, etc., in order to keep pace with the work of the machine. The labor has been reduced by one-half, while the work done has been increased about two-thirds per day, thus effecting a great saving in time and labor.

The machine is driven by two hydraulic rams, the small one for forcing and the large one straining. The small forcing ram—pump—is worked by a screw driven by worm gear and strap by power from line shafting, which arrangement gives a steady flow of pressure in the large cylinder, and does away with the objectionable intermittent reciprocating action of the ordinary plunger pumps, which may affect the real accuracy of a test when strain has gone beyond the limit of elasticity. The capacity of the forcing to the straining cylinder is such that the cubic contents of both are nearly equal, so that the displacement is nearly the same at either side of the piston, the one forcing and the other drawing, the water leaving the bottom side of the large ram while it is being forced down on the top side; therefore, when a piece is being tested and it breaks, the water under the ram acts as a stop and so prevents it from falling through any distance, and thus causing a sudden jar on the ram or steelyard levers, which jar is injurious to the knife edges of the machine.

The levers are compound and of the first and third orders, are graded 100 to 1 and balanced; the fulcrums have long knife bearing edges, viz., one inch equal to five tons, and are hardened to wear well. The traveling jockey weight, which is 10 cwt. standard imperial weight, runs on rollers guided by a groove, and can be worked automatically or by hand out and in on the main lever, which is just kept floating at the level of a finger pointer fixed to the column. The jockey weight is worked by a quick pitched screw through the center of the main lever, which is in turn worked by a pair of small toothed wheels, one of which is fixed to the machine column, and the other to the lever and on the dead center of the first lever. The pitch line of the toothed wheels being exactly in a line with the dead center knife edge, the motion at this point is virtually nothing. It is at the same time at right angles to the line of knife edge, consequently cannot disturb the sensitiveness of the steelyard when in operation. The machine is fitted with strong steel links, the top one being on knife edges on the lever, and the bottom one receiving the screw for adjusting the length for the test pieces; the screw is secured inside the trunk of a large ram. The ends of the links for receiving the test-pieces have round sockets with circular glands let into them, into which are fitted the tapered grips, so that the grips can be adjusted and turned in either direction, either to stand across or lengthways of the machine. The machine is specially adapted for tensile testing, but can be easily made to do either compression or bending testing if required. The machine is compact and easily got at for repairs, examining and readjusting knife edges; it takes up little space, and the gearing, being a worm and screw driven by belts, is noiseless. The levers, links, and ram are made of Hallside steel.





FIFTY-TON TESTING MACHINES, DESIGNED BY THOS. WILLIAMSON.

Another machine of the same description has just been erected at the Steel Company of Scotland, Blochairn Works, Glasgow.

Along with the testing machine it was deemed necessary to have a machine capable of preparing the requisite number of test-pieces to keep the testing machine fully employed, and for this purpose the test-piece shaping machine was designed by Mr. Thomas Williamson, and made by Messrs Joshua Buckton & Co., Leeds. The pieces, about twenty-five in number, of various thicknesses, and from one and one-half inches to two inches broad, just as they are cut at the shears, are put into the frame which forms a slide working across the bed of the machine; the pieces are roughed down and finished in one operation to a breadth of one inch to three-quarters of an inch; they require no filing up, except taking off the ragged edge, when they are ready for testing.

The average working of the machine is 150 test-pieces per day of nine hours. It is a strong, substantial machine, and has given great satisfaction both at Blochairn and Newton, and can prepare more than double the usual number of test-pieces at half the former cost, so that it forms a valuable adjunct to the lever testing machine.—*The Engineer.*

THE INFLUENCE OF SURFACE CONDITION ON THE STRENGTH OF STEEL.

Those who are best informed concerning what has been done during the last few years in the way of experimenting with steel, can hardly have failed to perceive that much of the work of investigation is being and has been done over and over again. It is difficult to imagine how much more can be deduced from the pulling of bars asunder in the testing machine. Many thousands of specimens have been thus broken. These specimens have been various in form, in length, and thickness; but it has been impossible to obtain from the manner of fracture of the specimens broken any solution of the problems which vex the hearts of steel makers and steel users alike. It has long appeared to us that a new departure was needed, and that experiments with steel should go over ground now untraveled. It is, we think, necessary before further progress can be made that a given phenomenon in the behavior of steel should be selected, and that experiments should be conducted to ascertain the cause of the phenomenon; or if a theory be put forward to explain it, then this theory should be tested. To carry out this work fully and properly involves of necessity a considerable expenditure of time and money; but it is possible for many individuals to spend both, and so by degrees sound information may be acquired which will ultimately prove useful.

Acting on this conviction we have carried out the inquiry, particulars of which we now place before our readers. We have to thank Professor Kennedy, of University College, for making these tests, and Messrs. Richard Garrett & Sons, of Leiston, for the specimens tested.

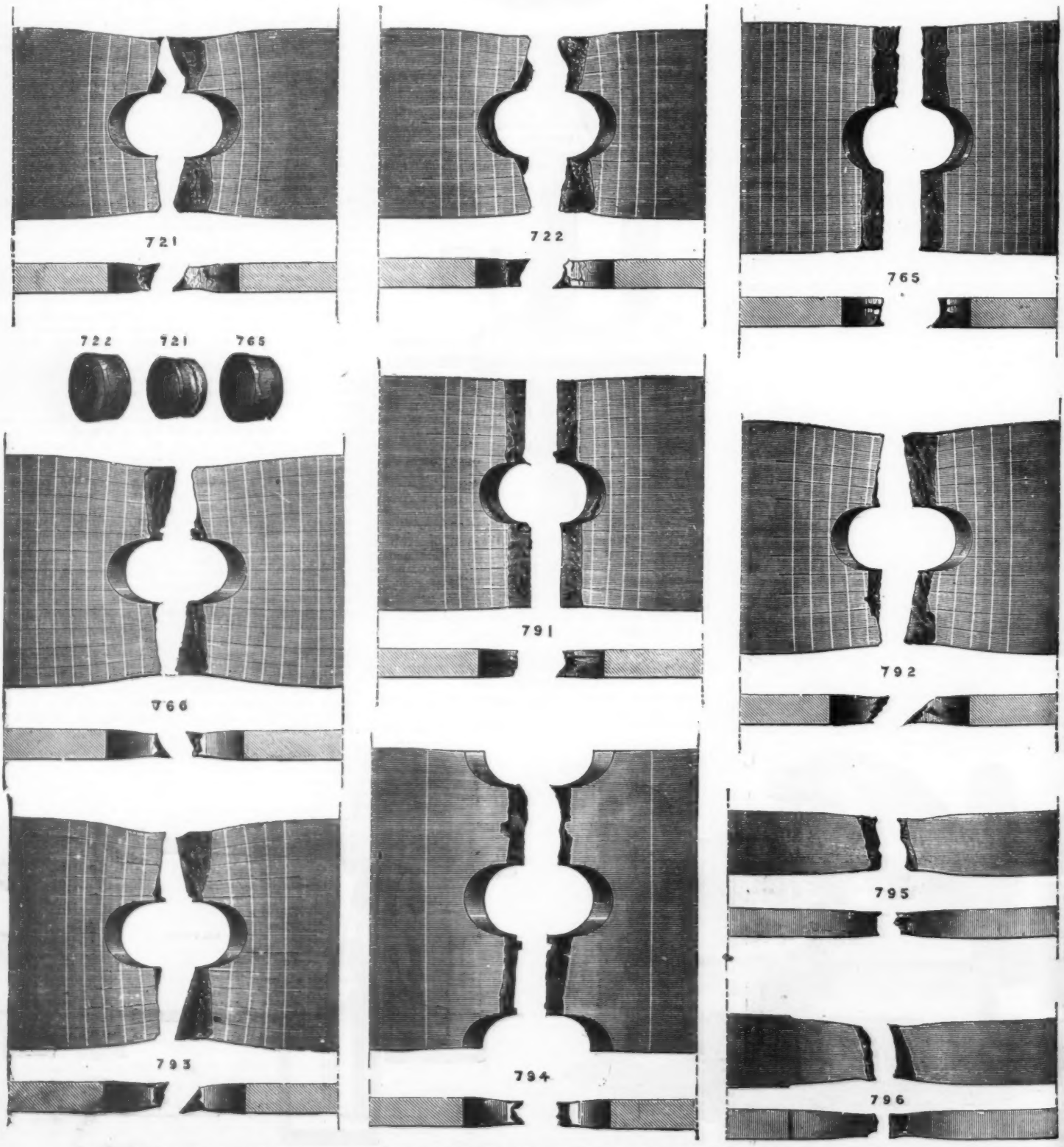
Dr. Siemens has put forward, as an explanation of the ease with which steel with ragged edges breaks, the case of a strip of India-rubber. This will bear a severe strain with ease until a very small nick is made in its surface, when it will gradually tear through. Something of the same kind is seen when a draper nicks with his scissors the edge of the calico or linen he wishes to tear across. Steel is supposed to give way thus because it is homogeneous. Iron will not so fail because it is made up of a number of layers of fibers, each of which may to a certain extent be regarded as homogeneous. If a dozen pieces of calico were pasted on top of each other, then the nicking with a scissors of one of the thicknesses would not insure the tearing across of the whole for obvious reasons. Now a good deal of evidence of a positive character is available to prove that Dr. Siemens is right; but what may be called negative evidence is lacking. If ragged edges promote the breaking of specimens of steel, then it seems possible that the smoother the edge can be made the less likely will the steel be to break, and to test this point has been our object.

As a preliminary inquiry an experiment was made to test the relative influence on the strength of a plate of first punching a hole and then rimering it out, and next drilling a hole and then punching it out to full size.

The result is set forth in Table I. The bars were not annealed, but were heated, that they might be leveled. All the specimens used throughout the investigation were cut from the same plate of Landore S S steel. The figures on the drawings are those stamped by Professor Kennedy on the specimens. 722 shows the piece punched out of specimen 722, which broke as shown in the engraving. A hole half an inch in diameter was first drilled in the plate, and then a seven-eighths inch hole was punched. The punch was sharp and filled the boss well. 721 shows the punching from specimen 721. The cupping of the punching is very well marked. It will be seen that punching and rimering gave a better result than drilling and punching.

The next experiment was intended to show the influence of smooth surface on the strength of the specimen. In this case one hole was punched and the other drilled. The punching is shown in 765, and the nature of the fracture in the engraving of the broken bar, also number 765. Both these bars were annealed after the holes were made by heating them to a dull red in a coke oven; they were then withdrawn and allowed to cool slowly. The hole in No. 766 was subsequently very carefully burnished, and the extreme edges were removed. It will be seen that No. 765 gave a bad result. The steel is nominally 30-ton fire-box steel, but the specimen gave way at little over 24 tons. The specimen, No. 766, on the contrary, stood, it will be seen, 31·85 tons, and the extension was very good. The results are set forth in detail in Table II.

The third series of experiments was intended to carry the inquiry a step farther, wider plates being used, and of the



TESTS OF THE STRENGTH OF STEEL UNDER VARIABLE SURFACE CONDITIONS.

strongest form, as shown by No. 794. The first bar, No. 791, had a hole punched with a seven-eighths inch punch. Bar No. 792 was drilled with a seven-eighths inch drill. The hole was carefully polished and very slightly countersunk on both sides. No. 794 had a seven-eighths inch hole drilled, and two seven-eighths inch semi-circular notches were made in the edge. The surface of the holes and of the notches was got up to a high polish, all sharp corners being removed. Nos. 795 and 796 were straight strips of plate nearly one inch wide and without holes, which were tested for the sake of comparing the solid with the perforated plate. The results are set forth in Table III. It will be seen that the best result obtained was that from 794, the strain on the contracted area being much in excess of that of any other perforated specimen. A special comparison may be made between No. 792 and 793 with advantage.

The experiments do not go far enough to permit them to be regarded as proving the proposition that the character of the surface of a steel plate, whether that surface be on the sides, or the edges, or constituting the periphery of an orifice, exerts a powerful influence on the strength of the steel, but they tend strongly to confirm this view, and we have very little doubt that if the experiments were extended over a greater range of specimens, it would be found that, in all cases, excessively small cracks, notches, and tears in a surface weaken a steel bar or plate very much. The question is well worth pursuing.

We have endeavored, as far as is possible by wood engravings, to give our readers a good idea of the nature of the fractures, but we feel that it is impossible to do this adequately. In the case of No. 794 the surface of the fracture is beautifully silky.—*The Engineer.*

TABLE I.

U.C.I. Test No.	Dimensions.	Nett area.	Absolute: Limit of elasticity.	Absolute: Breaking load.	Ratio of limit of elasticity to breaking load	Limit of elasticity: lb. per sq. in.	Limit of elasticity: Tons per sq. in.	Breaking load: lb. per sq. in.	Breaking load: Tons per sq. in.	Extension of holes.	Remarks.
		sq. in.		lbs.						in.	
791		0·702	none	50,050	—	—	—	71,300	31·83	0·37	Hole punched ¾in. diameter and rimed out, piece marked A, when received.
792		0·707	none	45,350	—	—	—	64,150	28·64	0·29	Hole drilled (probably ¾in. diameter) first, then punched out. Piece marked B, when received.

TABLE II.

U.C.I. Test No.	Dimensions.	Nett area.	Absolute: Limit of elasticity.	Absolute: Breaking load.	Ratio of limit to breaking load	Limit of elasticity per sq. in.		Breaking load per sq. in.		Extension of rivet hole. Mean.	Remarks.
		sq. in.	lb.	lb.		lb	Tons.	lb	Tons.	In.	Both pieces planed at edges
795		0·936	38,700	50,800	0·761 (Punched	41,350 hole.)	18·46	54,380	24·27	0·116	Limit not very marked. Fracture almost entirely crystalline, except a small zone of irregular form round hole, which is finely granular. Granular structure also shows itself round edges of piece.
796		0·922	35,700	60,570	0·536 (Drilled	38,250 hole.)	17·08	71,306	31·85	0·452	The hole in tails plate was not only drilled but carefully burnished, and all corners taken off. Fracture silky granular throughout.

TABLE III.

U.C.I. Test No.	Dimensions.	Area.	Maximum load per sq. in. original area. lb.	Maximum load per sq. in. original area. Tons.	Final area after fracture	Percentage of reduction of area.	Ratio of actual breaking load to max. load.	Stress at fracture per sq. inch actual ar lb	Stress at fracture per sq. inch actual ar Tons.	Final extension.	Remarks.
		sq. in.	lb.	Tons.	sq. in.	Per cent.		lb	Tons.		
791		0·937	53,200	23·21	0·854	8·9	1 : 1	59,340	26·06	Hole stretched 10·3 %	Punched hole. Annealed after punching, fracture crystalline, with exception of a dull grey irregular zone round margin of hole.
792		0·923	72,940	32·56	0·712	23·3	1 : 1	95,080	42·44	Do. 41·9 %	Drilled hole. Annealed after drilling, fracture silky, extension greatest at middle.
793		0·931	72,400	32·31	0·654	29·8	1 : 1	103,100	46·01	Do. 48·9 %	Drilled and burnished holes. Annealed after drilling, fracture silky, extension greatest at middle.
794		1·013	77,800	34·73	0·670	34·2	1 : 1	118,200	52·76	Do. 57·1 %	Drilled and burnished holes. Annealed after drilling, fracture silky, extension greatest at middle.
795	0·935 × 0·439	0·401	67,940	30·32	0·192	52·1	87 : 1	124,000	55·3	17·6 %, in 10" 39·0 %, in 2" at fracture.	Not annealed. Fracture silky, slight lamination visible.
796	0 ·928 × 0·415	0·403	66,940	29·89	0·212	48·0	89 : 1	114,100	50·96	16·5 %, in 10" 31·5 %, in 2" at fracture.	Not annealed. Fracture silky.

MAGNETS.

M. Trouvé finds that if three steel bars of the same length and size are magnetized, then demagnetized, and afterwards remagnetized, the magnetic power due to the first magnetization being represented by 2, 3, 4, the power of the seconp will be 4, 9, 16. He found it necessary to demagnetize very regularly. To magnetize the bars he placed them in two solenoids in juxtaposition, closed the magnetic circuit by means of two soft iron plates, and caused a current to pass from a battery of six Wollaston cells. He thus obtained magnets of great constancy. He states that straight magnets support twelve or fourteen times their weight; if the magnet be of horseshoe form it will support forty-eight or fifty-six times its own weight.

STEEL AND HEMP HAWSERS.

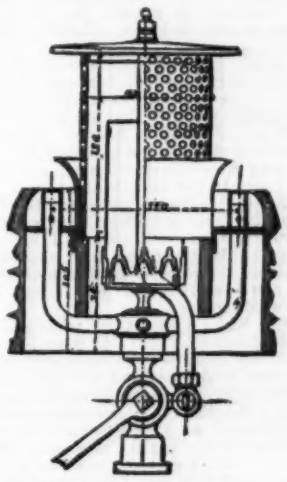
In shipping circles a good deal of interest has been excited in connection with an animated discussion which has sprung up in the columns of the Sydney *Morning Herald*, touching the comparative strength, weight, endurance, etc., of steel and hemp hawsers. As the matter is of some importance to many of our manufacturing readers, and of general interest to the trade in its broader bearings, a few of the leading points of the controversy may be profitably reproduced here. The dispute appears to have centered around a recent piece of towing, undertaken in connection with the steamship Hankow during a heavy gale, while the vessel was lying off Plymouth Breakwater. One of the correspondents of the newspaper mentioned above narrated the circumstances as a proof of the incontestable superiority of steel-wire hawsers —as showing, indeed, their advantages in point of strength as well as lightness. This brought forward a champion of the old-fashioned hemp hawsers, who adduced some rather powerful evidence in support of his allegations. He stated that one of the tugs had a hemp hawser of 18 or 20 inches in diameter, and a steel warp of 7 or 8 inches—one over either bow of the Hankow. Two other tugs had steel hawsers—which broke under the immense strains to which they were subjected, while the hempen rope proved equal to all the demands made upon it, and was the means of the vessel ultimately being safely harbored. The inference drawn by this correspondent is that the weight of the hempen hawser was all in its favor, and that the lightness of steel warps must always stand in the way of their being successfully used in heavy weather—in fact he predicts that they will "never supersede the old-fashioned ropes." If weight is to be the test of merit, we should probably be inclined to agree with the gentleman just quoted. Taking "one consideration with another," however, we resist this conclusion, our impression being that there is no comparison between the two classes of hawsers, and no doubt of the superiority of steel wire ropes, as made by the best manufacturers. As a matter of fact, the steel hawsers score under every head. They are lighter, handier, more flexible, occupy less room when coiled or otherwise stowed away, are more easily handled, less affected by water, stretch less freely, are stronger, more durable, and in many sizes are cheaper. These are not mean considerations on shipboard, where weight and space are money, whether the vessel is in port or at sea. It may suit the advocates of the "good old times" and sticklers for ancient usages to prefer hemp to steel, but the latter is an overpowering competitor, and must sooner or later utterly rout its respectable but more bulky and weaker rival.—*The Ironmonger.*

NEW GAS BURNER.

Among the different systems of intense gas burners recently devised, should be mentioned the splendid apparatus invented by Messrs Marini & Gœzler. The principle upon which this new burner is based is simple—a well directed and good distribution of those currents of air which are utilized for obtaining a steadfast, white, and brilliant flame.

Experience has shown that it is impossible to employ glass chimneys to guide a flame of great intensity. In the apparatus under consideration a guiding device placed within the flame preserves the proper form of the latter and keeps it from dividing. By examining the accompanying cut it will be seen that this burner is circular, and, although they are not here shown, its upper surface contains 250 apertures in a single line. After traversing a regulator, the gas is led into this perforated crown through four supply tubes. In the center there is a night-light provided with an ordinary butterfly burner, which may be used either for lighting the burner under consideration or as a night-lamp.

In this apparatus the manner in which the air is supplied is particularly interesting. First, there is an external current of air led by a crystal tube bent at its upper extremity; and second, an internal current which follows a copper cone placed over the first. Besides this double current,



NEW GAS BURNER.

which constitutes the ordinary supply of a glass gas burner, there is a new device which serves for leading a special current of air from outside of the lantern. This consists of a cylindrical porcelain tube, pierced with holes, covered by a convex disk, and supported by a crystal tube which is prolonged as far as the base of the burner. This new current divides into two parts—one of them passing through the first apertures of the porcelain tube, and the other through the apertures of the upper part. There are thus obtained with the same burner jets of variable intensity, and the consumption is from 42 to 70 cubic feet per hour under favorable conditions. This burner is designed for use in a round lantern of a large size, hermetically closed. With a supply of 42·5 cubic feet per hour there is obtained, with the porcelain tube, a light equal to that from 17 carcel burners, equivalent to 2·5 cubic feet per carcel.

The flame of these burners is round, united, steady, and long; and the strongest draughts disturb it but momentarily, and without the production of smoke.

The inventors are also making, on the same principle, burners of medium intensity for use in globes or in small size lanterns.

GOODYEAR & McKAY SOLE SEWING MACHINES. BOOT AND SHOE SEWING MACHINES.

The sewing of the sole to the upper of boots and shoes, by means of thread, is one of the oldest methods employed in the shoemaker's art. We have the delineation on the walls of tombs in Thebes of men engaged in this employment, and tightening the thread with their teeth. In the Abbott collection in New York is the mummied foot of an Egyptian lady, with the white kid gaiter boot remaining on it. The upper of this boot is sewed to the sole, but it has no heel. It is from Sakkarah, and is over three thousand years old. Several pairs of shoes worn by the Romans two thousand years ago are still preserved in the museum of Mayence, and these have the outer and inner soles sewed together with thread, and the uppers fastened in the same manner.

Making shoes by hand has long been a fine art in England and France, as well as in this country, but as a smart workman could only sew the bottoms on to about three pairs a day, the attention of inventors was directed toward quickening the process, and with very favorable results.

The first machine made for sewing leather was patented in England, by Thomas Saint, July 17, 1790. It is numbered 1,764 among British patents. It possessed many of the elements of the modern sewing machine, as can be seen by the drawing and explanation of the points which we give:

This machine was intended for "quilting, stitching, and sewing, making shoes and other articles by means of tools and machines." It possessed (1) a *horizontal cloth plate;* (2) an *overhanging arm,* on the end of which was (3) a *vertically reciprocating straight needle,* and on the top of which was (4) a *thread spool, giving out its thread continuously;* (5) an *intermittent automatic feed* between stitches; made the *chain stitch;* and had thread tighteners above and below. This is marvelous. Its parallel is to be found in the sixteenth century revolvers and repeating fire arms in the European museums; weapons that were made before the voyage of Columbus.

A machine for sewing leather was patented in the United States by J. J. Greenough, Feb. 21, 1842.

It had a needle which was passed through and through the material by means of pincers traveling on a track, and opened and closed automatically. The machine was specially designed for leather and other hard material, and the needle was preceded by an awl which pierced a hole. The material to be sewed was held between clamps and provided with a rack, which was moved both ways, alternately,

to produce a *back stitch*, or continuously forward to make the shoemaker's stitch. The material was fed automatically at a determinate rate, according to the length of stitch required. The machine had a weight to draw out the thread, and a stop motion to arrest the machinery when a thread broke or became too short. The needle was threaded with a length of thread, and required refilling. The feed was continuous to the length of the rack bar, and then it had to be set back. The machine was not specifically useful, but possessed some valuable points.

At the World's Fair, in London, 1851, "a machine for sewing leather" was exhibited by Charles R. Goodwin, of Boston. It worked entirely on upper leather, and we find no record of its having been patented here.

The first machines patented in this country for sewing leather were Wickersham's, April 19, 1853, and Butterfield's, July 4, 1854. No successful attempt at sewing the sole to the upper seems to have been made prior to that of Mr. Blake.

About the year 1858, Lyman R. Blake, a young journeyman shoemaker, employed by Gurney & Mears, of Abington, Mass., began to bring to a successful close a series of experiments he was making with a view to sew boots and shoes on a machine. He obtained his first patent July 6, 1858. The specification is as follows:

The shoe is supported on a horn provided with a thread carrier. A hooked needle penetrates the sole and upper, and takes the thread from the thread carrier and forms the chain portion of the stitch in a channel cut in the outer face of the sole. A cast-off works in connection with the needle. The horn is so shaped as to allow the stitch to be formed near the shoe around the shoe. Blake's patent, July 6, 1858.

The first public exhibition of the work of this machine was made in the autumn of 1858, in a room in Tremont Row, Boston, a few shoe manufacturers being present. The stock used was furnished by A. S. Moore & Co., of Lynn. This machine did not sew around the toe. It had no guiding seam channel, and shoes had to be heated on a steam chest to allow the wax threads to pass through easily. Nevertheless, it was hailed by the manufacturers as a great step of advancement in the making of shoes, and it was so.

Some time after this Mr. Blake patented in England a sole sewing machine with revolving head, which would sew around the toe. It is known now as the Goodwin machine, and was exhibited at the Paris Exhibition of 1878. It only runs by foot power, and sews 100 pairs a day. One of these is still used in this country.

In 1859 Mr. Blake sold out the right and title in his machine to Gordon McKay and I. G. Bates for about $8,000, with which money he went South and engaged in the shoe trade. The war broke out and he returned, having lost everything, and after that became identified, as he still is, with the McKay machine, as it has since been called. His interest never ceased, as he was to have, by terms of the sale, in addition to the original sum paid, $50 for each machine used or sold thereafter, and two cents a pair for each pair made until he received the sum of $62,000.

Mr. Blake put up the first machines outside of Massachusetts in the factories of Thomas Miles & Son, and D. R King & Co., at Philadelphia, and George Stribley, of Cincinnati. The civil war had caused a scarcity of men, and stimulated the demand for boots and shoes. Orders for machines poured in, and the services of the inventor were rewarded by a share in the business of the company, which led him, as well as them, on to a great fortune.

The interest of Mr. Bates was purchased, and Gordon McKay assumed full charge of the machine. He remedied defects in the working, and set about introducing it to the public—a hard task—with an entirely new and untried article, which was expensive in the first place, and in regard to which there was great fear that the work made with it would not stand. It was handled, however, by a thorough mechanic and business man, and Mr. McKay never rested until he had perfected his machine as far as human ingenuity could effect it. His first attempt was to made a revolving head and stationary horn. Lyman R. Blake took out, in connection with McKay, a patent on the product as well as on the machine. This, of course, covered all shoes sewed by machinery, and left the field clear, as long as the patent lasted, to the operations of the McKay Sole Sewing Machine Company. A patent of H. Mathews, of Boston, for channeling the leather, was purchased and put on about 1862, and in 1864 Mr. Blake devised the method of heating the horn, as is now done, and this made it possible to manufacture fine as well as coarse shoes on the machine. There was also a variable stroke patent—one for regulating the length of the loop so as to sew through thick and thin leather without changing the machine, and a patent for giving double speed to the machines if made necessary by press of business. All these, and others of minor importance, were added to the machine as it stood originally, and with it, as now furnished to manufacturers, go channeling machines, feather-edging machines and bobbin winders. Patents were taken out in every civilized country.

The next step was to get back some money for the outlay. It was evident that the sale of machines would be only a limited one, at least until after the patents ran out, and then anybody could construct them. To put a large price on the machine would keep it out of the hands of manufacturers of limited capital, and Col. McKay conceived the idea of leasing the machines for a nominal sum ($1), and charging royalty on each pair made. This was made payable by stamps which the manufacturer agreed to put on the soles of each pair of shoes, and an ingenious little contrivance affixed to each machine was made to tell whether he did so or not. The price of stamps was as follows:

	Cents.
Children's shoes	½
Misses' "	1
Women's "	2
Men's "	3
Boys' "	2
Youths' "	1
Slippers	1

The income of the McKay Association from the sale of stamps for several years was as follows:

1863	$38,746.51
1864	99,157.63
1865	160,776.15
1866	181,404.97
1867	210,225.36
1868	286,011.93
1869	356,026.06
1870	400,011.08
1871	486,083.09
1872	564,501.22
1873	589,973.81

After the year 1873 the records of the amounts collected for royalty were withheld from the press, but it is known that the rate of increase shown in the above table kept well up, and for the past three years, at least, the amount paid to the association has averaged a million of dollars a year.

In 1862 a certain amount of stock in the association was set aside for manufacturers, every purchaser of $100 worth of stamps getting a share. The last was taken up in 1875. This was a sort of premium given to manufacturers to interest them in the association.

The machines were introduced in Europe soon after they came to be used here. In England Pococke Bros., of London, put in the first in 1865. The charge for royalty was 10 cents for 1,000 stitches. The machine is known there as the Blake Sole Sewer. About 600 of them are used in Great Britain, and probably 4,000,000 pairs of shoes sewed on them yearly. The largest number there are run by Turner Bros. & Hyde, of Northampton, who have seven. Stead, Simpson & Nephews, of Leeds, etc., run six, and Snow & Bennet, of Leicester, and Derham Bros., of Bristol, six machines each.

On the continent of Europe perhaps 150 of the McKay machines are in use. The royalty both there and in Great Britain ceased some years ago.

The term of the main patents on the McKay machine expired August 14, 1881. The company have already made arrangements with many leading manufacturers, by which the latter pay $250 for the machines and all improvements, and the royalties cease from the above date. Others, however, decline to accede to this arrangement, basing their refusal on the following clause in the lease:

That this lease and license shall continue (provided the lessee complies with the terms and conditions thereof) until the expiration of all the letters patent which the lessee is hereby licensed to use, or any extension or renewals of the same; and upon the expiration thereof, the lessee shall deliver to the lessor, his successors, legal representatives or assigns, the machines hereby leased in good order, natural wear and tear alone excepted; and the lessee shall thereupon, if he has kept all the conditions of this lease and license, have the right to purchase said machines for the sum of one dollar.

The company claim that this covers only a machine *without improvements*, and claim royalty from all who do not pay the sum of $250. This matter may have to be settled in the courts.

There are now 50,000,000 pairs of boots and shoes sewed yearly on this machine. Eighteen hundred of the machines are in use. Up to 1875 the number sewn was 225,000,000 pairs in all. Probably nine-tenths of all the shoes made in this country for the past five years have been made on the McKay machine. The company have, in return for the royalties paid, kept the machines in perfect order, and added valuable improvements from time to time. The trade in the United States owes its high status to this great invention, and, viewing it in that light, the proprietors have not been overpaid.

The only machine successfully adapted to making welted shoes—and it will make turns as well—is that of the Goodyear & McKay Sewing Machine Company. The first man to patent the curved needle was August Destory, the date being Feb. 18, 1862. He attempted to adapt it to sole sewing, but with little success, until Charles Goodyear, Jr., oldest son of the great inventor in the field of India-rubber, took hold of it and made improvements which place it now in the front rank of sole-sewing machines. The records show nearly a dozen improvements put on this machine since its invention, and now it will sew with equal facility the finest infant's shoe or the heaviest, coarsest boot or brogan for the farmer's or miner's use. The advantage in shoes made by this machine is, they can be repaired with the same facility as hand-made work, and they are fully as pliable and comfortable for the wearer. The specification says of the welt machine:

The boot or shoe, properly lasted, is mounted upon a jack supported upon a shaft, which is connected by a joint to the treadle lever in the bottom of the column. The last holder or jack is constructed to turn in any direction, and can be inclined at a greater or less angle, with reference to the sewing mechanism, thus making the needle dip more or less, or point out as desired.

The great feature of this invention consists in the employment of a needle, working within a circle of *less than two inches in diameter*, thus overcoming the great difficulty which has always existed in adapting sewing machines to this work. After many years of investigation and experiment we are satisfied that for welted work *no approximate results even* are possible with straight needle machines, and for turned shoes no other machine has been produced which meets the requirements of manufacturers of all classes of work.

Another important feature is the needle guard, working concentrically with the needle, forming a brace, which supports the point of the needle in entering the work and in drawing up the stitch, thereby preventing the springing or breaking of needles. In operation this brace or support goes down with the needle until the point of the needle enters the work, and there remains until the needle returns, supporting it close to the barb, when the greatest strain comes upon it in drawing up the stitch.

One of the late improvements consists in the addition of a device for preventing the spreading of the seam, or the pulling through of the stitch, when the insole is soft and spongy, so that a poorer insole may be used than formerly.

The machine for stitching outsoles to welts is a very simple and substantial machine, and very easily operated It is provided with a straight awl and circular needle, this combination being *peculiarly adapted to the work, the circular needle being indispensable in sewing in the hollow of the shank*, or even in sewing around the forepart, when the work is properly done.

Of machines for sole sewing, using a curved needle, a patent was granted to Dunham in 1862. This machine for making turned shoes we also illustrate.

The following is the specification:

Machine for making "turned" shoes. The shoe and last are carried on a jack, *a*. A chain stitch is formed by a hooked needle, which passes through the sole and upper, and takes its thread from a thread carrier. The awl, *b*, perforates the material for the passage of the needle. Dunham's patent, September 9, 1862.

During the Centennial Exhibition at Philadelphia two sole-sewing machines were shown. They were of American manufacture, but were never brought into the trade. The field is open for them and all others now.

The Cutlan sole sewer has the chain of stitches embedded and buried in the channel, and not exposed next to the foot. It does good work, runs light and easy, and is owned by a Philadelphia company.

The Miller sole sewer is for turns only. It sews on women's and children's work, and claims to be easily guided and to give good work. The inventor is a Philadelphia manufacturer.

The Keats sole-sewing machine is the invention of John Keats, of England, and made in this country by the Providence Tool Company. It is a durable lock-stitch, fastening with two waxed threads, and presents some very good features.

The Pearson sole-sewing machine, an English invention, is being introduced here by John O'Flaherty, of Montreal. It has a new, quick speed arrangement from continuous whirl and variable stroke. This machine, which could not heretofore be sold in the United States, is favorably known in Europe.

The Scott sole-sewing machine is a New York invention, and a recent candidate for public favor. The machine is simple in its construction, having comparatively few parts, and is a form of those machines for sewing together the sole and upper leather of boots and shoes in which the waxed and heated thread, being carried upward through a revolvable member called the "horn," passes through a whirl in the top of the same, which, on the descent of the barbed awl or needle, engages the thread in the barb so as to be carried by the ascending needle up previously-formed loop. A piece called the "cast off," covering the barb at the proper moment, permits the previous loop to slip off the needle and be drawn taut thereby in the manner familiar in "tambour" or "chain-stitch" work.

A sole-sewing machine, with straight needle, was patented by Ballou, Jan. 22, 1861, and improved in 1868, and again in 1875. It seems not to have come into the market.

The Mills machine, used in England, is similar to the Goodyear machine. It has a curved needle.

A machine for sole sewing, called the Staple machine, has been made in Fitchburg, Mass., the needle passing through the material, forming the loop and casting it off; it forms a staple inside the shoe.

These are the inventions put before the manufacturers for sewing shoes. Machinery in this line has largely superseded hand work, and, if they continue to invent and improve, the custom shops, and system of making shoes by hand, to measure, will become practically extinct. About 2,000 sole-sewing machines of all kinds are in use in the United States now.—*Shoe and Leather Reporter.*

METHOD OF DETERMINING THE RELATIONS OF THE ACTINISM OF DIFFERENT LIGHTS TO THE SAME ILLUMINATING POWER.*

THE actinism of the various sources of light used in photography varies, for an equal illuminating power, according as we use, for instance, solar light, electric light, burning magnesium or a gas jet, an oil lamp, or a candle. It was difficult to arrive at an exact determination of the actinic force of each of these different sources of light for an equal illuminating power, or, rather, for an equal action upon the selenium photometer; for it is not, perhaps, correct to say that the effects produced upon this apparatus are in constant relation to the illuminating power.

However, be that as it may, one thing is certain, namely, that the luminous rays, whatever their source, act upon the suitably-prepared selenium in such a way as to vary its electric conductibility according as the luminous intensity is greater or less. And it is easy—thanks to the arrangement of the selenium photometer, which is composed, as we know, of a plane selenium receiver, an electric generator, and a galvanometer, the three apparatus being united by the two conducting wires—it is easy, I repeat, to place the receiver in such a plane that it will receive a luminous action capable of producing an equal deviation of the galvanometric needle. We proceed tentatively, advancing or withdrawing the selenium, until the needle stops at a fixed deviation, which, in my experiments, was fifteen degrees. A sensitive plate is then substituted for the selenium, and printed for a certain time.

In this way an exposure was made of five seconds by diffused solar light on a collodion emulsion, the sensitive film being placed in the same plane in which the light, striking on the selenium, produced a galvanometric deviation of fifteen degrees. This done, I replaced the solar light by that of a candle, and sought by means of the selenium the exact plane in which the apparatus, when struck by the rays emanating from the candle flame, underwent an action measured again by fifteen galvanometric degrees. An impression effected here, and with the same duration of five seconds, only produced on development a tint much inferior in intensity to that produced in the same time by the light of day. I then made a series of exposures varying one from another of from five to ten seconds, and was obliged to reach an exposure of seventy seconds to obtain a result at all similar to that produced by the light of day in five seconds. From this we may conclude that the actinic power of solar light, as compared with the actinic power of a candle for the same degree of the selenium photometer, is as five to seventy—that is to say, fourteen times as great.

By this same method it is possible to compare the light of day with that of the other sources of artificial light. This is of great interest just now, since artificial light is becoming more and more used in photography. It will be possible, the actinic coefficients of each different source of light once known, to arrive at similar results whatever light be made use of. And, further, by means of the continued operation of the selenium photometer the luminous action may always be brought at first to a precise photometric deviation; and afterwards, even during the operation, the variations which may be produced in the source of light—as oftenest happens with electric illumination—may be followed, and the degree adopted as the base of the operations may be maintained constantly by changing the plane of action. No other apparatus would, with an equal facility, allow at this point the regulation of printing operations by means of artificial light.

To complete the account of my method I ought to state that the impressions should be made on films of like sensitiveness. For this end the best plan is to cut a sensitive plate into a certain number of fragments. Moreover, the development should be so effected that all the fragments of the same printed plate may be covered at the same time by the developer, and may undergo its action for an exactly similar period. To obtain this result, I place all the fragments of the same plate side by side at the bottom of a dish, and pour quickly upon them a tolerably abundant quantity of oxalate of iron. Then, when the development seems complete, I add water to the developing bath, so as to dilute it very much and deprive it of all its strength. I am thus certain to stop the development at the same time for each portion. After washing sufficiently they are fixed simul-

* A communication to the Photographic Society of France.

taneously, finally washed, and the result is tints which clearly indicate the differences of action or of actinism for the same photometric degree.—*Léon Vidal.*

OPERATIONS OF THE BRITISH POST OFFICE.

THE twenty-seventh annual report of the Postmaster-General has just been issued, from which the following particulars have been taken:

LETTERS.

The number of letters delivered in the United Kingdom during the twelve months was 1,176,423,500, showing an increase of 4·3 per cent.; the number of post cards, 122,884,000, an increase of 7·4 per cent.; the number of book packets and circulars, 248,881,600, an increase of 16·3 per cent.; and the number of newspapers, 133,796,100, an increase of 2·5 per cent. There is again a marked increase in registered letters, the number recorded being 10,034,546 against 8,729,191 of the previous year, or an increase of 14·8 per cent.

The machinery of the department has necessarily been extended; 337 new sub-offices have been opened, raising the total number of such establishments to 13,637, which with 912 head offices makes the grand total of post offices 14,549 About 620 letter boxes have been added, and the number of receptacles of all sorts for letters may be stated at 27,709.

Eight hundred officers have been added to the force, which, on the 31st of December last, had reached a total, including all grades, of over 47,0 0 persons, of whom over 2,000 are women. The success obtained in employing women as clerks in the Savings-bank and the Receiver and Accountant-General's office has led to their number being considerably increased.

Hitherto these clerks have been appointed upon a plan of limited competition, three being nominated to compete for each vacancy. In future, however, the appointments will be made through open competition, subject to rules issued by the Civil Service Commissioners. Another important extension of the principle of open competition has been carried out, male and female telegraphists in London, Edinburgh, and Dublin being now appointed in this way. The health of the 10,900 officers employed in London has been generally good; the death rate, uniformly low, has fallen to a point below any previously recorded, the actual number of deaths in London being 45, and the rate per 1,000—4·1.

Among the incidents of the year may be mentioned snow storms of extraordinary violence, which, impeding railway communication and severely taxing the energies of the department, occasioned large additional expenditure. On the 18th of January no night mail could be dispatched from London, and on Friday, the 4th of March, five carriages were blocked in the snow in Scotland, and were not extricated till the following Monday, while the Sutherland and Caithness Railway was completely closed for a fortnight. However, during the whole period of the storm, not a single mail bag was lost, nor throughout the year did any accident occur involving the loss of a life engaged in the postal service. A letter containing a £1,000 check, which should have been posted in Lombard street on the 18th of January, was found on the 24th in the Thames near Deptford, among some snow drift which had evidently been carted from the city and thrown into the river. The letter, which had never passed through the Post Office, was duly returned to the sender.

During the Christmas week more than 11¼ millions of letters and packets, over and above the ordinary correspondence, and four tons of extra registered letters, representing a total postage of nearly £58,000, passed through the central office. To meet such extraordinary pressure the services of volunteers from other departments of State were obtained after office hours, and the assistance thus procured was found most valuable.

Over 5,300,000 letters were dealt with in the Returned-Letter office, 475,000 of which it was found impossible to deliver or return. One contained a bank note for £100, still unclaimed; and attached to the seal of another was a sovereign, which was returned to the owner, who had forgotten to remove it. In addition to the letters about half a million of post cards, four million of book packets, and 400,000 newspapers found their way to the same office. More than 27,000 letters, an increase of 3,000 over last year, were posted without any address whatever, 5,000 furnished no clew to the sender, and 1,340 contained articles of value to the amount of nearly £5,000.

The use of too fragile covers occasioned the escape of some 30,000 articles, and no doubt entailed much disappointment. The habit of transmitting animal and perishable matter, such as fish, sausages, birds to be stuffed, clotted cream, fruit, yeast, salads, jellies, live kittens, and dead rats still prevails; and it is necessary to appeal to the public to discontinue a practice so injurious to the health of the officers in one branch of the department, and to repeat the warning that such forbidden articles will be stopped. The return of a letter posted without an address to a firm whose direction appeared within led to the discovery of a systematic robbery of goods and the apprehension of the offenders. At Hull an incident occurred proving the elasticity of the postal organization under heavy pressure. The distribution of nearly 300,000 circulars weighing 20 tons, issued by a single company, and representing £2,380 worth of postage, was effected without confusion or delay in 48 hours. The dispatch necessitated the employment of seven extra railway vans, and it is believed that all the documents duly reached their destination.

PARCEL POST.

In October last a Postal Conference, attended by the secretary of the department and Mr. Benthall, one of the assistant secretaries, was held in Paris to consider the possibility of establishing an international parcel post. After much discussion, an agreement was arrived at, providing for the transmission throughout almost the whole of Europe of parcels not exceeding three kilogrammes (about 6½ lb) in weight, at very moderate charges. It was, however, impossible for Great Britain to sign the treaty which embodied these conclusions without having previously established for herself an inland parcel post.

TELEGRAPHS.

The telegraph business of the United Kingdom continues to increase; the messages sent were more numerous by 3,419,828 than in the previous year, and the aggregate reached 29,936,965. During the year 107 new offices were opened, and the total number now stands at 5,438. The new main line from London to towns in the north of England and to Scotland, commenced in 1880, and, now complete, forms an important addition to the system, and the wants of the metropolis and its neighborhood are being met by a considerable multiplication of wires. The snow storms in January occasioned many breakages and much labor. Messages sent by persons unable to reach their homes added to the pressure on the department, and on the 19th of January the central office alone dealt with some 6,800 messages above the average number.

TELEPHONES.

On the 20th of December an important decision of the Exchequer division of the High Court of Justice, defining the rights of the department in connection with telephones was given against the companies which had established exchanges, but after much negotiation an agreement was concluded which, while protecting the interests of the public, afforded reasonable advantages to the companies concerned. The system of telephonic intercommunication is, therefore, now being extended partly through the agency of companies and partly by the Post Office. The department has in course of completion telephone intercommunication systems at Swansea, Glasgow, Greenock, Hull, Manchester to Liverpool, Newport to Cardiff, Leicester, Sunderland, and other towns, and is receiving applications from many quarters.

SAVINGS BANKS.

Much has been done during the year to encourage thrift. On the 22d of November, 1880, an act came into operation by which any person desiring to invest any sum between £10 and £100 in government stock can do so through the agency of a savings bank at a trifling expense, varying from 9d. to 2s. 3d., and have the dividends collected free of further charge. The purchase can be effected either by transferring money from the depositor's account or by means of a sum specially deposited for immediate investment. Between the 22d of November and the 31st of March the amount thus transferred through the Post-Office savings banks was £151,465, and the amount specially deposited £231,674, making an aggregate of £382,139 invested by about 6,300 persons, and it is satisfactory to notice that the sales did not exceed £7,500. The stock certificates, with coupons payable to bearer, obtained under section three of the act, were, in the period stated, 63 in number, and £4,950 in amount.

Notwithstanding the channel thus opened, the total amount of deposits, with the interest due, had, on the 31st of December, reached £33,744,637, showing an increase of £1,732,503 over the amount recorded on the corresponding day of 1879. The Post-Office savings bank year, prescribed by statute, terminates on the 31st of December, but comparing the financial years ended 31st March, the result obtained is: The total amount of deposits, on the 31st of March, 1880, including interest to previous 31st of December, £33,5 8,405; the total amount of deposits on the 31st of March, 1881, including interest to previous 31st of December, £34,782,329; estimated increase in the financial year ended the 31st of March, 1881, £2,203,924.

The attention of the department had for some time been drawn to the demand for a minimum limit of deposit lower than the shilling prescribed by Parliament. With a view to meet this demand and to encourage the saving of very small sums, the Postmaster-General adopted a plan which was submitted to him by Mr. Chetwynd, the Receiver and Accountant-General. Small slips of paper, specially prepared, were provided by the department, and distributed gratis, with an intimation that, if twelve penny postage stamps were affixed to them, they would be accepted as a deposit of one shilling. The plan was, in the first instance, tried as an experiment in certain counties in September last. Before it had been in operation for more than a few weeks, its success became so marked that the Postmaster-General decided that on the 15th of November it should be extended to the whole country. The cleanly condition in which the slips arrive is worthy of notice. The number received to the close of March was 576,560, and it is estimated that 233,000 new accounts originated in this manner.

The number of Post-Office savings banks now open in the United Kingdom is 6,302 as against 6,016 mentioned in the last report.

The condition of the savings banks in Ireland is still a subject of peculiar interest. The increase of capital recorded in the previous year has not only been maintained, but has been augmented by £47,000, and is larger than any annual increase during the past ten years. The total amount, including interest, due to depositors on the 31st of December last was £1,555,900, being £138,500 in excess of the total of the previous year, exclusive of a sum of $17,000 invested in Government stock. The names of about 10,000 new depositors were added, and the proportion to population is 1 in 65 as compared with 1 in 74 in 1879. Every county in Ireland contributed its quota, and the increase in the eight counties scheduled as distressed amounted to £8,448 over and above the growth of the previous year—viz., £33,866 against £25 418.

POSTAL ORDERS.

Under the provisions of the "Postal Orders Act, 1880," a new system was introduced on the 1st of January, providing an inexpensive and easy way of sending small sums of money to different parts of the United Kingdom. This Act was founded on a bill introduced in the previous session by Lord John Manners. Drafts, entitled postal orders, can now be bought at any money-order office for different amounts, varying from 1s. to 20s., subject to a commission ranging from one halfpenny to two pence. In three months 646,989 of such orders were sold of the value of £292,150, producing commission to the amount of £3,750; and it is evident from the increasing demand that the public appreciate the convenience thus provided.

The decrease in the number of money-order transactions, which commenced in 1878, is again visible. The inland orders recorded show a falling off of 2·7 per cent. in number, and 2·2 per cent. in amount as compared with the previous year. This result is no doubt attributable to the increased facilities of transmission by other means, such as registered letters and postal orders. The number of orders for large amounts increase, and the foreign and colonial business exhibits a steady progress. Notwithstanding the diminution in the number of inland orders, the gross amount transmitted for the public was over twenty-six millions sterling, and the losses by fraud and default did not exceed £215. It will be seen that the decrease in the gross amount as compared with last year is nearly made up by the amount of postal orders issued in three months, and it may be expected that the results of both methods combined will eventually produce a total considerably in excess of the amount formerly transmitted by money orders alone.

REVENUE.

The gross revenue collected within the year was a little over eight and a quarter millions—that is, £8,367,311. The expenditure was £5,440,665. The net revenue was, therefore, £2,926,646, being an increase of £88,017 on the previous year.

The capital sum raised for the purchase of the telegraphs since 1869 exceeded ten millions sterling, and hitherto the results of the undertaking have exhibited an annual deficiency of interest amounting in the aggregate to not less than £1,316,000. For the first time, however, the net telegraph revenue for the year, viz., £328,878, has been sufficient to pay the full interest, 3 per cent. on the capital, and leave a real surplus of £2,462 toward the canceling of debt.

It is to be observed that, in consequence of the Savings-bank funds being vested in the National-debt Commissioners, no allusion is made in the accounts to the revenue and expenditure of the Savings-bank department, but the Postmaster General adds the following particulars: The expense of conducting savings-bank business during the year was £180,891, or £3,389 less than in the previous year. This apparent decrease of expenditure at a time when there was a large increase of business, was, in a great measure, due to the fact that the proportion of the cost of the new savings-bank building in Queen Victoria street charged to the year 1880 was much less than that charged to the previous year. The net profit paid over to the Exchequer by the National-debt Commissioners was £144,879. It would, therefore, appear that the real Post-office expenditure was £5,629,756, and the revenue was £8,701,081, showing a profit of £3,071,5 5.

THE CENTER OF POPULATION IN 1880.

THE first estimates of the census returns indicated that the center of population of the United States in 1880 would probably fall within the city limits of Cincinnati, Ohio. The fall returns, according to Census Bulletin, No. 145, show the center to be in latitude 39 deg. 4 min. 8 sec. north, and longitude 84 deg. 39 min. 40 sec. west. The position of the Old Observatory, Mount Adams, Cincinnati, is: Latitude, 39 deg. 6 min. 29·5 sec.; longitude, 84 deg. 29 min. 45 sec. The center of population for 1880 is, therefore, 2·6 miles south of this observatory, and 8·9 miles west of it. That is, it is 9·3 miles west by south from the observatory, or 8 miles west by south from the heart of the city of Cincinnati. This places it in Kentucky, one mile from the south bank of the Ohio river, and one and a half miles southeast of the village of Taylorsville.

The following table shows the movement of the center of population since 1790:

Date.	Position of center of population.	Westward movement during preceding decade. Miles.
1790.	23 miles east of Baltimore	
1800.	18 miles west of Baltimore	41
1810	40 miles northwest by west of Washington	30
1820.	16 miles north of Woodstock, Va	50
1830.	19 miles west-southwest of Moorefield, W. Va	39
1840.	16 miles south of Clarksburg, W. Va	53
1850.	23 miles southeast of Parkersburg, W. Va	55
1860.	20 miles south of Chillicothe, O	81
1870.	48 miles east by north of Cincinnati, O	42
1880.	8 miles west by south of Cincinnati, O	58
Total		457

The center of population as defined in the Statistical Atlas of 1874, "is the point at which equilibrium would be reached were the country taken as a plane surface, itself without weight, but capable of sustaining weight, and loaded with its inhabitants, in number and position as they are found at the period under consideration, each individual being assumed to be of the same gravity as every other, and consequently to exert pressure on the pivotal point directly proportioned to his distance therefrom." In brief, then, it is the center of gravity of the population of the country.

PUBLIC INSTRUCTION IN THE PROVINCE OF BOLOGNA.

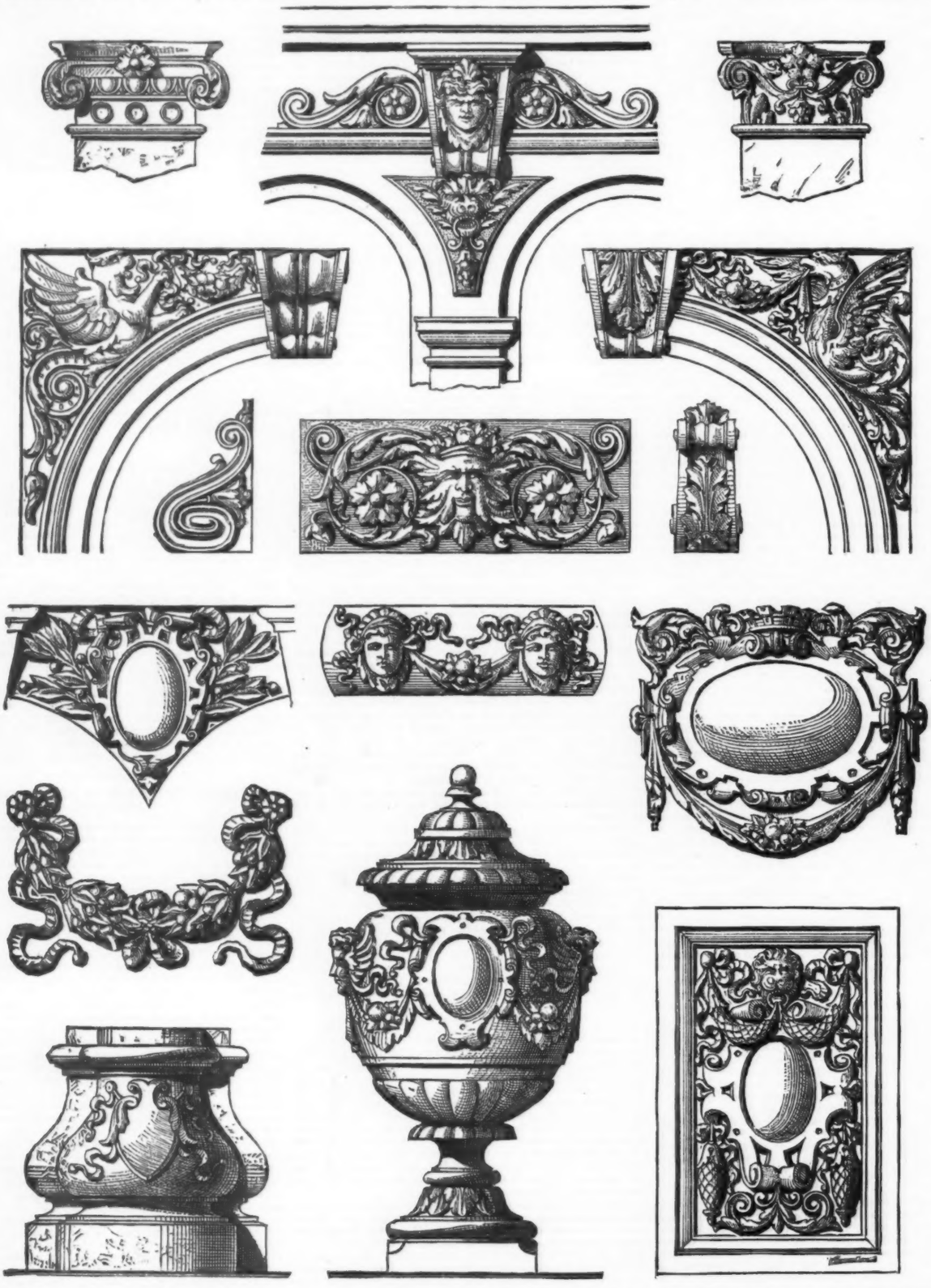
BRITISH Consul Colnaghi states that the law of compulsory instruction, passed by the Italian Parliament in July, 1877, has with satisfactory results been put in force in the commune of Bologna, where nearly the full complement of children required by law to be under instruction are present at the schools, with the exception of the mountain and country districts, where material obstacles as well as moral often bar the way to instruction, and the greatest difficulties have to be met by the officials on whom the execution of the law falls; there is, however, stated to be a serious defect in the law, which is, that instruction is compulsory only between the ages of six and nine, and to remedy this an attempt has been made to establish evening complementary schools. At the schools belonging to the commune of Bologna, religious instruction is no longer given; a clause in the Casarti law of 1859 was somewhat irregularly interpreted to effect this change, which has been in force since 1870; the effect of the abolition of religious instruction has, however, not been to decrease the number of attendants at the schools. Instruction in gymnastics is obligatory, and has been introduced in the schools of the commune of Bologna as well as in those of Imola, San Giovanni in Persiceto, S. Georgio di Piana, and other districts. Elementary gymnastic movements performed in school time on the benches are carried out in all the schools of the province. The number of schools in the province of Bologna in the year 1878–9 was 45, in addition to which there were 215 public evening schools for adult males, and 192 public fête day schools for adult females. Of the masters engaged in teaching at the evening schools, 6 are ecclesiastics, and 209 laymen; 210 hold permanent, and 5 provisional diplomas. Of the mistresses of the fête day schools, 183 are provided with permanent, and 9 with provisional diplomas. The evening schools are open only during the winter months, the fête day schools during the whole year. In addition to the municipal grant there is a government subsidy of 16,350 lire to be divided among the 407 teachers in the proportion determined by the provincial scholastic council. For secondary classical instruction the city of Bologna possesses a Royal Lyceum with 101 scholars, a communal gymnasium with 235, an archiepiscopal seminary (lyceum and gymnasium) with 93, a private lyceum and gymnasium with 91, and two other private gymnasia, one with 76 and the other with 5 scholars.

The city of Imola contains a communal school with 54 boarders and "externs," and an episcopal seminary with 24 scholars. Secondary technical education is given in two communal technical schools, one divided into two sections at Bologna with 330 inscribed scholars, and the second at Imola with 63. Bologna maintains an upper female school with 76 pupils, 30 in the preparatory class and 46 at the school. There are two government normal schools for the instruction of masters and mistresses for the elementary

schools; they are provided with 23 teachers, and are attended by an average of about 200 students.

For higher education the celebrated University of Bologna still flourishes, and maintains a good reputation by the assistance of distinguished professors; it contains four faculties —jurisprudence, medicine and surgery, mathematical and physical sciences (to which a school of application for civil engineers, maintained in part by the government and partly by the municipality, province, and other institutions has been added), and philosophy and letters, with various minor classes, and is frequented by about 500 students.

The Royal Technical Institute, established in 1862, is also the Spanish College, which was founded in 1364 by Cardinal Albornoz, and which still receives students, though not necessarily of Spanish birth, who attend the university lectures and the technical schools, Valeriani and Aldini, founded by the two celebrated professors of those names, the first as a school of design for artisans, the second as a physical and chemical cabinet, applied to arts and manufactures. These schools, united by the municipality, now give instruction to sixty-two pupils of the working classes. The Chamber of Commerce has recently annexed to them a school for the moral education of youthful artisans between the ages of thirteen and sixteen. Consul Colnaghi in his report states



SUGGESTIONS IN DECORATIVE ART.—ORNAMENTAL DETAILS IN RELIEF, BY PROF. A. BRAUSEWETTER, REICHENBERG, BOHEMIA.

very well attended. The province of Bologna is also largely endowed with charitable educational institutes; in the city of Bologna alone, the total patrimony enjoyed by institutions of this description, which included upper, secondary, and professional schools, an asylum for the blind, orphan asylums, schools for the deaf and dumb, and purses for poor students, amounted, in 1871, to 11,303,638 lire, with an annual income of 792,846 lire; in the rest of the province the patrimony of similar institutions amounted to 1,948,564 lire, with an annual income of 110,330 lire.

Among the principal institutions in the city of Bologna is that an important legacy was left by Dr. Francis Alberghetti to the commune of Imola. By the terms of his will the capital amount left to the commune was to be invested for thirty-one years, at the end of which period half was to be devoted partly to the establishment of a school attached to the local gymnasium for teaching mathematics applied to the arts, and in part to reward any inventions that might be deemed worthy in connection with art, industry, or agriculture. The other half is to be placed at compound interest, for another period of thirty-one years, when the same division is again to be gone through. The first division of the property will take place this year, when 486,085 lire will be available for the purposes mentioned; in 1911, the amount to be divided will be 791,042 lire; in 1941, 1,435,902 lire, and so in a constantly increasing ratio. If the commune of Imola fail in carrying out the wishes of the testator, the legacy reverts to the commune of Bologna.

THE GRAVE OF WILLIAM PENN.

A CORRESPONDENCE has recently been published concerning the proposal to remove the body of William Penn from England to America, where it would be reinterred with public honors by the authorities of the State of Pennsylvania. The history of the foundation of that State, as a colony of England, by the eminent Quaker teacher and reformer, under a royal grant from King Charles II. two hundred years ago, is known to all the world. It is fully related in the late Mr. Hepworth Dixon's biography of William Penn, and in the preceding work upon that subject by Clarkson, which was re-edited by the Right Hon. W. E. Forster, and to which Mr. Forster added a complete refutation of the erroneous imputations upon Penn's character that had appeared in Lord Macaulay's "History of England." It was

in the autumn of 1682 that Penn first went out to America, where he made an equitable treaty with the tribes of Indians on the Delaware river, and purchased a site for the city of Philadelphia, at the confluence of that river with the Schuylkill. He stayed about two years, organizing the new English settlement, the growth of which, by fresh emigration from this country, and from Holland and Germany, where the Quakers had large connections, was rapid and thriving in the next twenty years. In 1699 William Penn again went out there, with his wife and family, but came back in 1701. He died in July, 1718, at his country house, Ruscombe, near Twyford; and the proprietary right of government in Pennsylvania, with the territorial lordship and quit-rents enjoyed by his family, was afterwards purchased by the local commonwealth of Pennsylvania. The late Mr. John Penn, of Greenwich, the eminent designer and manufacturer of marine steam-engines, was the last of William Penn's lineal descendants bearing that illustrious name.

We have to thank a correspondent, Mr. Henry Liggins, of 3 Ladbroke Square, Notting Hill, for an interesting communication upon this subject, with sketches lately taken by him of the quiet little rustic graveyard and old Quaker meeting-house at Jordans, near the village of Chalfont St. Giles, in Buckinghamshire, about twenty-four miles from London. This was the burial place of William Penn, and of some other early members of the Society of Friends or Quakers. Our correspondent admires the secluded beauty of this sylvan spot, on the edge of the noble Wilton Park, in which are to be seen some of the finest trees in the kingdom, and which was for generations the home of the Du Pré family. The burial-ground of the Society of Friends was purchased in 1671; the meeting-house was built in 1687 or 1688, and was then by deed named Jordans. In 1748 a little more land was added to the graveyard, given by Samuel Vandervaal, and used as his burial place, which to this day remains separated from the rest by a row of trees. The Friends' Meeting House is a plain red brick building, with tiled roof and lattice windows, and with the frames, shutters, and doors painted white. The interior is of the plainest deal wood, unpainted. The graveyard is a parallelogram, rather large for a country place, perhaps over half an acre; and many a mouldering heap is visible; but the only memorial-stones are a few of modern date, all alike, not a dozen in number, marking the last resting place of the Penn family. They bear the names of two children of William Penn; namely, of Letitia Penn, and Springett Penn (1696), Gulielma Maria Penn (1689), Maria Pennington (1682), and Joseph Rule (1765); and also, on another stone, of the same shape and size of the above, about two feet high, "William Penn, 1718, and Hannah Penn, 1726." She was the second wife of William Penn, whom he married in 1696. His first wife, Gulielma Maria, daughter of Sir William Springett, died in 1689. The Society of Friends have, for some time past, ceased to hold regular meetings for religious worship at Jordans; but that place is annually visited by numbers of those Friends, from all parts of England, who attend their yearly meeting in Bishopsgate street, London, in the latter days of "the fifth month," which we call May. The trustees of the Jordans graveyard have positively declined to allow the removal of William Penn's body to America; and we are disposed entirely to commend their resolution, not only upon the ground of religious propriety, but regarding it as a matter of national interest to our own country. Penn's life and example, as a consistent English champion of civil and religious liberty—for Macaulay's blunders, in mistaking other persons of the same name for this eminent man, have been fully exposed—should always be cherished by his own countrymen, who would be unwilling to part with his mortal remains, even to the "Keystone State" of the Great English American Republic, where his principles are zealously upheld by a respectable portion of the citizens of Pennsylvania.—*Illustrated London News.*

THE GRAVE OF WILLIAM PENN AT JORDANS, BUCKINGHAMSHIRE.

IMPORTANT ARCHÆOLOGICAL DISCOVERIES IN ASSYRIA.

THE spade of the explorer has once more been busy amid the mounds and ruins of Assyria and Babylonia, and a rich harvest of antiquities has resulted from the work. The explorations carried out during eighteen months by Mr. Hormuzd Rassam, though affording no such *grande trouvaille* as the bronze gates from Balawat, have, nevertheless, been rich in discoveries which will be welcomed by all students of history and philology. The recovery of the library of terra-cotta tablets from the palaces of Sennacherib and Assurbanipal has restored to us a vast mass of literature and supplied long-lost chapters in the history, mythology, and science of the world. It has also proved to us that valuable as these records are, we have in them but second and third editions of works first compiled by the scribes in the library cities of Babylonia. The discovery of fragments led Assyriologists to hope that the explorer would be able to recover from the ruins of the cities of Chaldea the older versions of the Assyrian texts, and the expedition of 1880–81, which Mr. Rassam has just concluded, has so far met their wishes in that from the ruins of the temples and palaces of Babylon, Borsippa, Sippra, and Cutha he brings records and copies of religious texts, some of which will, no doubt, furnish the required Chaldean versions.

From the earliest days of Mesopotamian travel the spade of the explorer has been applied to the ruins of Babylon. Strange as it may seem, although for more than three centuries the ruins have been known and visited, and for centuries the Arab brick merchants have been digging amid its ruins for bricks, it is only within the last few years that records of importance have been recovered. With the exception of thousands of bricks bearing the names and titles of Nebuchadnezzer, and cylinders inscribed with the records of temples and palaces built or restored by the builder-king and his successors, no record of historical or scientific importance has been recovered from amid the ruins. But the year 1874 began a new era in Babylonian explorations, for from that time on there has been a continuous flow of inscriptions and records from the treasure-house of the city; and we now know much more of the popular life of Babylon and its people than after years of study we have been able to ascertain regarding Nineveh from monuments and records. The tablets found by the Arabs in 1874–5 were purchased by the late George Smith for the Trustees of the British Museum, and the subsequent finds made by Mr. Rassam have added some hundreds to this branch of the collection, so that of this class of tablets there are now more than 3,000 examples in the British Museum. These tablets show that for a long period, probably several centuries, the family of the Beni Egibi were the leading commercial firm of Babylon, and to them was confided all the business of the Babylonian Ministry of Finance. The building whose ruins are marked by the mound of Jumjuma was the *chancellerie* of the firm, and from its ruins come the records of every class of monetary transactions. The documents being all most carefully dated and compiled, are of great value to the chronologist and historian; while to the student of Babylonian civilization they are of the highest importance. From the tax receipts we learn how the revenue was raised by duties levied on land, on crops of dates and corn, on cattle, by imposts for the use of the irrigation canals and the use of the public roads. It is almost impossible to estimate too highly the importance of such a series of documents as these, dealing with every phase of social life, and coming to us from a city within whose walls were gathered representatives of every "nation, people, and tongue."

The inscriptions which Mr. Rassam has recovered are not confined to documents of this class only. It was long feared by Assyriologists that Babylonian history was irretrievably lost, as no historical records were recovered, but from the ruins of the palaces of the Kings of Babylon, Mr. Rassam has brought fragments of historical inscriptions of Nebuchadnezzar, a valuable *précis* of the history of the last days of the Babylonian Empire, extending from the seventh year of Nabonidus to the fall of the city before the hosts of Cyrus, a royal record of the Persian conqueror, and lastly, an inscribed record of the last great victor who entered Babylon, Alexander of Macedon. The scarcity of stone in Babylonia and the extensive use of bricks rendered the ruins of Babylonian palaces not fruitful fields for the explorer in search of architectural remains. In the ruins of the Kasr or "palace" mound, Mr. Rassam has found chambers and corridors which formed part of the royal residence of the Kings of Babylon. The use of plaster and painted bricks as decoration in these chambers affords strong support to the statements of the Greek writers as to the mode of decorating the royal residences of Babylon. On the extreme north of the ruins of Babylon, and partly without the *enceinte*, is the large mound called by the natives the Babel mound. Excavations made here have brought to light the remains of extensive hydraulic works, wells, and conduits lined with stones, and evidently connected with the Euphrates. The discovery of these remains would seem to indicate that here had stood the hanging gardens, built by the Babylonian king for his Median Queen, and the supposition receives additional support from the recovery of a small inscribed tablet, which clearly proves the fondness of the Babylonian kings for horticulture. A scribe attached to one of the palace or temple libraries of Babylonia has transmitted to us a list of the gardens or paradises of the Babylonian monarch, Merodachbaladan, the contemporary of Sargon, Sennacherib, and Hezekiah. This monarch appears to have been a lavish patron of horticulture, for the list furnishes the names of more than sixty gardens and parks in and about Babylon constructed by the royal order.

Leaving Babylon, we now cross the Euphrates and pass south-west to glance at the work which has been carried out on the ruins of the Birs Nimroud, the traditional site of the Tower of Babel, but really the ruins of the seven-staged Ziggurat, or observatory tower of the great Temple of Nebo at Borsippa. Excavations in the Birs have brought to light several chambers of the ancient temple, and also afforded much information regarding the construction of the stage tower. From this site Mr. Rassam has brought some fragments from the great mass of vitrified bricks, which has so long been a puzzle to travelers, and it is to be hoped that some student of science may explain the cause of this vitrifaction. Babylon may claim to be the mother of Nineveh and the cities of Assyria, yet among the cities of its own land there were those which could lay claim to far more ancient traditions, and even to being the ancestors of Babylon itself. All students of history and antiquity will welcome the discovery made by Mr. Rassam of the sites of two of these ancient cities, whose records and traditions carry us far back to the days when, perchance, Babylon was as yet "a little village." While in the neighborhood of Bagdad, Mr. Rassam heard from the Arabs of some ruins, on the banks of a half-dry canal, called by the Arabs Yusuffieh, where plenty "written stones were to be found." The mounds to which his attention was directed were called Deyr, and were situated on the north bank of the canal, about thirty miles south-west of Bagdad. The test trenches cut in the mounds did not bring to light any very important remains, only a number of inscribed bricks of the time of Nebuchadnezzar, and no information was afforded as to the site represented by the ruins. But if the mounds of Deyr were drawn blank, a more fruitful spot was awaiting the touch of the explorer's wand to burst forth into a rich harvest of discoveries. While working at Deyr Mr. Rassam

paid a visit to the mounds called by the Arabs Tell Abu Hubba, where his test trenches soon rewarded him for the disappointment of Deyr. The mounds of Abu Hubba are very extensive, covering an area over two miles in circumference, and the position of the walls and citadel are clearly marked by mounds and embankments of *débris*. Like most Babylonian edifices, the buildings at Abu Hubba are built with the angles to the cardinal points.

The citadel occupies the southern portion of the *enceinte*, and its highest point was on the south west face, which was once on the banks of a broad canal or a branch of the Euphrates, the bed of which is now represented by the dry channel of the Ruthwaniyeh Canal. In the interior of the edifice an interesting pair of rooms were discovered and cleared of *débris* by the fortunate explorer, and it is from records found in these chambers that we have been able to ascertain the name of the city and the nature of the edifice whose ruins are buried beneath the mounds of Abu Hubba. In excavating a trench, following a wall in the central portion of the mound, a doorway was found leading into a large gallery or chamber one hundred feet in length and about thirty-five feet in width. In this chamber were the remains of a large brick altar nearly thirty feet square, and evidently the great sacrificial altar of the temple. In the wall of this chamber a door was found leading into a smaller room, which, from its construction and position, Mr. Rassam considered to be the record chamber of the edifice. In his explorations at Ballawat, which we fully described some time since, Mr. Rassam found the memorial records of the builder of the great temple of the Assyrian war god placed in a stone cist and buried near the altar. The scarcity of stone in Babylonia caused the builders of the temples at Abu Hubba to inclose the records in a cist made of terra-cotta and to bury this beneath the floor of the chamber. The shaft sunk by the excavators employed by Mr. Rassam brought these precious records to light, and from them we are able to ascertain the name of the city and temple whose ruins have been discovered. The first three lines of the largest of the foundation records bring our speculative thoughts to a focus and center our minds on the traditions of one of the most ancient cities of Chaldea: "To the Sun-god, the great lord, dwelling in Bit-Parra, which is within the city of Sippara." Here, then, we have restored to us the ruins and records of a city whose traditions go back to the days before the Flood, when pious Xisuthrus, by order of his god, "buried in the city of Sippara of the Sun the history of the beginning, progress, and end of all things" antediluvian. And now we recover, twenty-seven centuries after they were buried, the records of the pious restorers of this ancient temple. Such a discovery as this almost makes us inclined to dig on in hopes of finding the most ancient records buried there by the Chaldean Noah.

There are many points of history raised by this inscription, but it will suffice to say that from the earliest days of Babylonian history the city of "Sippara of the Sun" was a prominent center of social and religious life. The excavations, therefore, at Abu Hubba have restored to us the ruins of the great temple of the sun god, "the House of light," in the Chaldean Heliopolis. The monuments reveal to us the fact that there was a second city of Sippara, whose ruins are probably marked by the mounds of Deyr, and which was dedicated to the goddess Anat or Anunit, and the two cities of Sippara may be identified with the cities of Sepharvaim, mentioned by the Hebrew writer of the Second Book of Kings. This discovery is greatly enhanced by the further discoveries made by Mr. Rassam in another grave mound of Chaldea. The excavations which the explorer made in the mounds of Hubl Ibraheem, some ten miles east of Babylon, have restored records which prove that beneath these ruins were the remains of the temples and palaces of the city of Cutha, one of the great theological centers of Babylonia. In the southern portion of the larger of the two mounds at Hubl Ibraheem, Mr. Rassam found extensive remains of buildings, chambers, and corridors, and the inscribed bricks and tablets recovered point to these edifices as being the remains of the great Temple of Nergal and his consort Laz, which was restored by the great temple builder Nebuchadnezzar. To the Biblical scholar the discoveries of these cities, Sepharvaim and Cutha, is a great gain, for from them were brought the men of Sepharvaim and the men of Cutha, who were placed in Samaria by the Assyrian conqueror, Sargon (2 Kings xvii. 24-31). The descendants of these worshipers of Adrammelech and Anammelech, and Nergal, the god of Cutha, are now to be found in the small white-robed congregation who gather round the high priest Yakûb in the synagogue at Nablus. The traveler who visits these lost remnants of the seed of Israel may carry his thoughts far back beyond the days of the Captivity, into the azure of the past, to the days when the ancestors of these men made the courts of Bit-Parra echo with hymns of praise to the Sun, the "lord of light and golden rays." The above is the record of an explorer's short campaign amid the buried cities of Chaldea, and its results are such as lead us to hope for richer discoveries in the future from the land where center all the traditions of the history and religion of Western Asia.—*Times* (*London*).

ON SPECTROSCOPY.

By DR. L. CIAMICIAN.

THE following are the results of the examination of the spectra of certain compounds and of twenty elementary bodies: Carbon, like other elements, has a spectrum of the first, and another of the second order. Cyanogen, carbon oxide, and acetylene are the only carbon compounds having a special peculiar spectrum. The spectra of cyanogen and of carbonyl have a simple relation to those of their components of the first order. The more refrangible side of the spectra of cyanogen and of carbon oxide is homologous to the same side of the spectrum of the first order of carbon, and the less refrangible half of the spectrum of cyanogen is comparable to that of the spectrum of the first order of nitrogen.

The spectra of the first order of carbon, boron, silica, and aluminum has no corresponding part in those of carbon and boron, and might be compared to the less refrangible region of the spectra of the elements of the oxygen group. Boron, silicon, and aluminum have spectra of the first order corresponding to that of carbon. The spectra of the first and second order of carbon and magnesium are respectively perfectly homologous. The more refrangible part of the homologous spectra of barium, strontium, and calcium is homologous with the spectrum of magnesium. The spectra of oxygen, sulphur, selenium, and tellurium are perfectly homologous among themselves, both in the more and the less refrangible portion.

The spectra of phosphorus, arsenic, and antimony are only comparable with those of nitrogen as regards the red portion. The spectra of the halogens and that of fluorine are homologous only as regards their less refrangible portion. The less refrangible part of the spectra of silicon, aluminum, calcium, strontium, and barium is homologous to the same portion of the spectra of the oxygen group. The elements which are best comparable are those placed in a horizontal series in the tables of M. Mendelejeff. These are: Sulphur, silicon, aluminum, calcium, selenium, strontium, tellurium, and barium.

The more refrangible parts of the spectra of chlorine, bromine, iodine, phosphorus, arsenic, and antimony are homologues of the more refrangible parts of the spectra of the elements of the oxygen group. The spectra which are best comparable in this respect are those of sulphur, chlorine, phosphorus, selenium, arsenic, tellurium, iodine, and antimony.

The relations of homology of the elements as just explained, and the homology of the spectra of cyanogen and carbon oxide with those of their component elements, lead to the supposition that the homology of the spectra of the elements has its ground in their mode of composition. This view, taken in conjunction with the regularities of atomic weights as detected by M. Mendelejeff, gives rise to the following conclusions: The spectra of carbon, boron, and magnesium are perfectly homologous among themselves. These three elements are therefore composed of equal matter in different states of condensation, which are manifested by the displacement of the homologous lines. The atomic weights of carbon and boron differ very little; that of magnesium is $24=2\times12$.

The spectra of silicon and carbon are respectively homologous, the more refrangible side corresponding to the spectrum of carbon, and the less refrangible side to that of oxygen. Silicon is, therefore, a compound of carbon and oxygen conformably to its atomic weight, $28=12+16$. Aluminum contains carbon under the form of boron (perhaps under that of glucinum), as indicated by its atomic weight, $27=11+16$, this carbon being combined with oxygen. The metallic elements of the group of alkaline earths produce spectra, the more refrangible part of which corresponds to the spectrum of magnesium, and the less refrangible part to those of the elements of the oxygen series. Consequently, calcium, strontium, and barium are composed of carbon under the form of magnesium and oxygen under the condensation forms of sulphur, selenium, and tellurium, according to their atomic weights (calcium$=24+16$, strontium $=24+4\times16$, barium$=24+7\times16$). The elements of the oxygen group are composed of one and the same matter in different states of condensation, manifested by the displacement of the groups of the homologous lines of their spectra. The atomic weights of the elements of this series are: Oxygen$=16$, sulphur$=16+1\times16$, selenium$=16+4\times16$, tellurium$=16+7\times16$.

The halogens are all composed of fluorine and oxygen in different states of condensation, as shown by their atomic weights: chlorine$=19+16$, bromine$=19+4\times16$, iodine$=19+7\times16$. The spectra of the elements of the nitrogen group are homologues, in their less refrangible part of that of nitrogen, and in their more refrangible part of those of the oxygen group.

These elements are, consequently, compounds of nitrogen and of oxygen more or less condensed, as appears from their atomic weights: Nitrogen$=14$, phosphorus$=14+16$, arsenic $=14+4\times16$, antimony$=14+7\times16$.—*Ber. Kaiser. Akademie der Wissenschaft. Wien.*

PHYSICS WITHOUT APPARATUS.

A CORRESPONDENT of *La Nature* sends that journal the following description of an interesting and easily-performed experiment, to accompany the excellent series of articles on

LIFTING WITH THE FINGERS.

"Physics without Apparatus," which we have recently reproduced in our pages. The experiment, which is illustrated in the annexed cut, consists in lifting a person by means of the fingers only. Two individuals place the forefingers of their right and left hands under the feet of the person to be lifted; two other persons place the forefinger of their hands under his elbows, and another places the same finger under his chin. At the command, *one, two, three!* each person makes a vigorous effort upward, and the individual under experiment is lifted up with surprising ease. Although the experiment never fails to astonish those who behold it, there is really nothing wonderful about it when we reflect upon it. It is a simple example of equal distribution of weight. A man weighs on an average about 150 pounds, and each finger, therefore, lifts about 21½ pounds.

A correspondent of the *Electrician* sends that journal the following interesting experiment in electricity:

Take a pasteboard box about 8 inches long, 5 inches wide, and 2 inches deep, and cover it with a sheet of very clear glass. Collodionize the upper surface of the glass several times, without, however, allowing it to lose its transparency. Then place in the box figures of insects made out of sponge or cotton. In dry weather, when the collodionized surface is rubbed with the dry fingers, the insects will be seen to move about and be attracted and repelled whenever the fingers approach the glass cover.

DOUBLE REFRACTION.

By A. CORNU.

THE author sums up the results of his experiments as follows: 1. In quartz the mean of the speeds of propagation along the optical axis of the circular waves of inverse directions is sensibly equal to the speed of the ordinary wave perpendicular to that axis. 2. In Faraday's heavy flint glass the mean of the speeds of propagation of circular waves of inverse directions separated by the magnetic action is sensibly equal to the common speed of these waves when the magnetic action is null. He proposes the following more general statement: The splitting up of a wave polarized rectilinearly into two waves polarized circularly in opposite directions is effected in such a manner that the mean of the speeds of propagation of the split up waves is equal to the speed of propagation of the single wave, which exists in conditions where the causes of splitting up do not act.

MICROSCOPY.

AT the recent meeting of the American Association, Dr. Geo. M. Steinberg, of Baltimore, read a paper entitled "Contributions to the Study of Bacterial Organisms, Commonly Found on Mucous Surfaces and in the Alimentary Canal of Healthy Individuals."

He stated that while the term bacteria indicated a genus of those small microscopic organisms that are to be found in decaying animal and vegetable tissues and in the air, yet it was often used in a general way for them all. He mentioned the fact that many are of the erroneous opinion that each disease is produced by a microcosm peculiar to itself. He had made many examinations of blood, and could state positively that neither in health nor disease could any living organisms be found in it. Even in septicæmia there are none to be found. When bacteria or micrococci are injected beneath the skin the blood will not exhibit their presence. He suggested that the white corpuscles of the blood absorb into themselves any animalcules that enter into the blood stream. It is the characteristic of amœba, which the white corpuscles resemble, to take up any granules that come into their way. The saliva contains sarcinæ and other bacterial organisms. In persons who scour their teeth and wash their mouths a great deal they are not so plentiful, but still they are to be found. The coating of the tongue is largely made up by them. By pressing a glass slide against the moist orifice of the male urethra they will always be found. The alimentary canal of human beings is never without parasites. Bacterial forms are to be found on the mucous membrane of the rectum, as evidenced by transferring on a slide the moisture gathered from tissue paper. They are also to be found on the mucous membrane of the bronchial tubes—larger and smaller. The mucous membrane of the bladder is free from microscopic organisms. The alkaline fermentation of urine is, no doubt, due to the organisms at the anterior portion of the urethra. The Doctor detailed a number of interesting experiments with urine to prove this assertion. He stated that urine first passed from the bladder was placed in a bottle, and that passed last was put in another bottle. The first specimen soon became cloudy with fermentation; the second was found to be clear after several days. It was evident, in these experiments, that the passing of the first urine washed away all bacteria, so that the last specimen was free from them, and consequently kept free from all change. Animalcules changed urine into carbonic acid.

Prof. Thomas Taylor described the construction of a "new and improved freezing microtorm," for the purpose of freezing tissues, of which extremely thin sections are made for microscopic examination. It is a very ingenious instrument indeed, and does great credit to the inventor. Prof. Taylor is microscopist to the Department of Agriculture in Washington. He had proposed its use to Dr. Bliss, with the view to freezing the integuments, for anæsthetic purposes, at the time President Garfield was operated upon when a pus cavity was opened.

A paper was read by Dr. Lester Curtis, of Chicago, on the "Study of the Blood After a Protracted Fast."

It will be remembered that quite recently a Mr. John Griscom finished at Chicago a fast that had continued for forty-five days. Dr. Lester assured the meeting that Griscom's fast was a genuine fast—no humbug about it. Dr. Lester examined his blood microscopically soon after Griscom ate his last meal. It was found to be healthy in every particular—the corpuscles of a natural appearance both as regards color and form. The examinations were kept up every day of the fast while it lasted. The second day of the fast there was not a great deal of change in the blood corpuscles; but after that time they began to show abnormal appearances, changing form more or less almost every day. Some of the figures exhibited by the Doctor showed the red corpuscles to be drawn out at great length. Some of them appeared serrated. At times during the fast they were pear shaped, and then, on other days, they would assume some other shape.

THE CONDENSER SUPERSEDED.

M. RUPALLEY writes to *L'Electricité* as follows: "I was present a few days since at an interesting experiment which was carried out at the Lycée at Rouen, in connection with the singing condenser. The experiment was the result of chance investigation by one of the young men employed in the physical laboratory at the Lycée. You know that in the ordinary experiment the speaker into which one sings is placed in the induction circuit, and the ends of the wires of the induction coil are connected with the terminals of the condenser. In the experiment which I saw, the condenser was not used, though the induction circuit remained unchanged, the ends of the wire of a moderately strong coil being simply brought into close proximity, at a distance of about three millimeters. Each time the speaker vibrated, a spark passed between the two wires, and at the same time it sang so clearly as to perfectly reproduce the song which was sung into the transmitter and almost as loudly as when the condenser was employed. What should we obtain if we caused the spark to pass in a gas, other than atmospheric air, say, for instance, carbonic acid? Would a Geissler tube filled with carbonic acid at a feeble pressure sing?"

A NEW CURRENT OF INDUCTION ELECTRICITY; OR, A NEW METHOD OF PRODUCING ELECTRICAL NERVE AND MUSCLE REACTIONS.*

By WILLIAM J. MORTON, M.D., New York.

IN a paper on Statical Electro-therapeutics or Franklinism, read before the New York Academy of Medicine, March 3, 1881, and printed in the New York *Medical Record* of April 9, I stated that an induction current could be obtained from the frictional induction electric or Holtz machine, and that this current produced nerve and muscle reactions similar to those produced by the induction currents now in common medical use under the general designation of faradism.

This current I claimed to be novel, probably, to the physics of electrostatics, and certainly to medical practice. After the reading of the paper, the very simple manner of producing the current from the Holtz machine and its reactions in the persons of many members of the Academy were demonstrated, and it was generally conceded that, as compared with the ordinary induction currents now in use, the static-induced, as I ventured to name it, produced maximum muscular contractions with a minimum amount of pain.

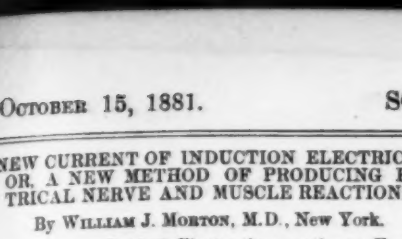
The object of the paper referred to was to call attention to the neglected claims of frictional electricity, or franklinism, as produced from the Holtz machine and its modifications, in the treatment of disease, an object toward whose attainment I felt the more impelled, since there existed at the time in American medical literature no treatise or publication to which the physician could apply for guidance and information on the subject. For, though of sporadic instances of the individual medical use of statical electricity there were doubtless many instances, no systematized effort at its introduction into practice had been made.

It is gratifying to note the interest in the matter that has now sprung up. Many electrical machines of a variety of patterns have been ordered of the makers, and we may soon expect to hear reports for and against the revived method.

Having, then, already elsewhere treated somewhat fully the general subject of statical electricity in its medical applications, I have nothing further to add until the experience of others comes forward to criticism.

In the meantime the only element of strict novelty in the revival of franklinic electricity is the induction current referred to, which places in the hands of the practitioner in the same machine, as I shall point out, both franklinic and faradic electricity. For this reason of novelty, as well as on account of the intrinsic interest and worth of the current to neurologists, I wish to emphasize, and to present the subject briefly to the members of the association.

Very soon after I began the study of the medical properties of statical electricity, my attention was struck by accidentally receiving from the conductors of the machine a thrilling sensation and contraction of the muscles, which exactly recalled the ordinary faradic current. Following out the clew thus gained, I constructed a new electrode for obtaining muscular contractions at any given point by means of the spark, while yet not allowing the spark to come in contact with the skin. This electrode I will describe briefly. Its main principle rests in the fact that if two statical and sustained potentials in the act of discharge are interrupted in the circuit by a series of spark discharges, the effect upon muscular fiber in some remote part of the current removed from the spark discharge is to be thrown into contraction. The accompanying cut illustrates the mechanical construction of the electrode. Sparks of a desired and given length between *a* and *b*, the distance between which may be regulated at will, cause muscle and nerve reactions beneath *c*, a wet sponge. The patient in this instance is not insulated.



I used this electrode for some time to avoid the pain of the sparks administered to children and timid subjects. But it soon became evident that the physiological effects of the spark and of the current thus interrupted were not identical, and I finally restricted the use of the electrode to those cases in which I had previously used the faradic electrodes, as, for instance, in exciting individual muscles, as in Bell's and other paralyses.

The more I used the electrode the more striking became the principle involved, and I proceeded with various experiments which I will not detail. The nearest approach to final success was an adjustable break in the circuit of the ordinary conducting wires held in the hand and connected with the two condensers of the machine. This caused merely a series of heavy, jerking discharges and corresponding contractions far from the smooth current desired. I next attached one conducting wire and electrode to the inside of one jar, and the other to the outside of the second jar, producing in this way a very fair resemblance to the faradic current. Finally, the effect desired, viz., a smooth and agreeable current, producing strong muscular contractions, was at last secured in a manner as simple as efficacious. It is as follows: We remove the connecting bar or chain between the two *outer* coatings of our Leyden-jars, connect our conducting wires, armed at one end by a small hook or by a clasp, to each outer coating respectively, and finally, connect as usual the two inner coatings by the discharging rod or rods. The subject or patient now takes hold of the two electrodes, not requiring, of course, to be insulated. As soon as the machine is set in motion and electricity generated, the discharging rod or rods may be drawn out a very small fraction of an inch, and at once a current is felt between the two sponge electrodes, which, in its general characteristics, cannot be distinguished from the ordinary faradic current. This current I have ventured to call the static-induced current. The muscles to which it is applied at once spring into energetic contraction. The response, I am persuaded, is quicker than that evoked by the induction currents in general medical use. Supposing, as experiments show, the time usually occupied by a muscular contraction is about one-twentieth of a second, preceded in each instance by a latent period, it would appear with the static-induced current that the latent period is curtailed, while at the same time Hallerian irritability is more rapidly evoked. This is a point, however, which could only be determined by careful experiments in the physiological laboratory. The obvious deduction in practice is that, in cases where it is of diagnostic value to determine early loss of faradic excitability, this can be done by very delicate currents of the static-induced. It is then a delicate test for the state of muscular irritability.

This current is, furthermore, soft and agreeable, and produces no shock. As has been said, it produces a maximum of muscular contraction with a minimum amount of pain. A comparison with the sensations experienced from a Ruhmkorf coil, a magneto-induction apparatus, or an ordinary galvano-faradic instrument, amply sustains this assertion. In treating children, the painless character of the current is an important consideration. Another peculiarity of the current is its high tension, indicated by its disposition to jump from the conducting wires in the form of fine prickling sparks. To prevent this—disagreeable alike to physician and patient—it is necessary to have the conducting wire or chain well insulated from the sponge upward. My electrodes are made with glass tubes for handles, while the wires are encased in ordinary black rubber tubing.

The strength of the current may be regulated to a nicety by means of the discharging rod or rods, ranging from an almost imperceptible tingle up to extreme and rigid flexion of the arms, should, for instance, the electrodes be held in the hands. To be obtained at its best, the electric machine must be generating a considerable *quantity* of electricity. If this is not the case, the tension at the same time remaining high, a "jerky" character in the current becomes evident.

The static-induced current will not, of course, be confounded with the series of discharges taking place between the inner coatings of the jars. This latter, in silent current forms, produces no muscular contractions or sensations of any kind. In repeated discharges, caused by an interruption in the circuit, it is too painful to be borne.

The modification in the manner of producing the muscle and nerve reactions thus far described, by means of the static-induced current, by connecting one conducting wire and electrode to the *inside* of one Leyden jar and the other to the *outside* of the second jar, has been already referred to. Thus produced, the current is not as smooth as when taking its sources from the outside of both Leyden jars, but this method may be pursued if desired.

The rationale of the term static-induced current and of its production would seem to be this: It is static, because its source is static electricity, just as we say, galvanic induction electricity. It is induced because the outer coatings of Leyden jars are electrical by induction in the same manner as the secondary coil is electrical. The inside of the jar may be said to correspond to the battery current of an induction coil—the outer coating to the secondary current. It is a current because it is an equalization of two potentials along a conductor, as in a galvanic current, where we have a + and a — potential. And to carry the analogy to the secondary current of an induction coil further, the interruptions at the discharging rod in spark form may be said to correspond to the interrupting hammer of the faradic apparatus. Each spark causes a rise and fall of potential in the interior of the two Leyden jars, and, as a consequence, a corresponding rise and fall in the induction of the outer coating. We have thus two supplies or potentials of opposite induction electricity on the outer coatings, and with each spark as many waves or induction impulses, whose strength is determined by the strength of the spark, that is to say, by the amount of the discharge permitted between the insides of our two Leyden jars.

This, then, is an entirely new current in medicine, and it is not a little curious that, with all the experience with frictional machines, it should have remained undiscovered up to the present day. The three main methods of administration of static electricity up to the time of the publication of my paper were by insulation, by sparks, and by shocks; the new current adds a fourth, which greatly widens the scope of medical statical apparatus, for by the simplest of arrangements the frictional machine is converted into a machine which will do all the work of the best faradic machine.

We thus have at command in a frictional machine all of faradism, in addition to the static electricity; for working purposes we have all the advantages of both systems. We have, moreover, a current superior to the faradic currents in use, in that it produces the muscle and nerve stimulation with a far less amount of pain. The new current, then, has a record yet to make, and I venture to hope that it may have a therapeutic future.*—*Medical Record.*

* Read at the annual meeting of the American Neurological Association, New York, June 10, 1881.

RELATION OF BRAIN POWER TO THE WEIGHT OF THE BRAIN.

IN an article on the Physiology of the Brain, in the *New York Medical Journal*, Dr. Ambrose L. Ranney says that the average weight of the brain of a healthy adult of the Caucasian race has been given by most of the prominent investigators upon this subject as about fifty ounces in the male, and some six ounces less in the female. In the newly-born infant the weight of the brain in the two sexes is more nearly alike, being about eleven ounces for the male child and ten ounces for the female. The rapidity of growth of the brain is not uniform throughout the different periods of life, since it grows rapidly until the age of seven years, then less rapidly until the age of forty is reached, when it attains its full development, and after that age it decreases in weight about one ounce for every period of ten years.

It may be stated as a rule that the relative proportion of the cerebrum to that of the cerebellum is greater in the intellectual races, and that the cerebrum is developed in individuals in proportion to their intellectual power, although the absolute size may not be taken as a guide to the quality of the mind, since it is undoubtedly true that the brain can be improved *in quality* by exercise, as well as the muscular system. That there are important individual differences in the quality of the generating nervous matter is evidenced by the fact that some small brains actually accomplish more and better work than larger ones, and that many women often show a higher degree of mental acumen than men, in spite of the fact that their brains are lighter.

In a carefully prepared table of the weight of brain substance possessed by men of renown as intellectual giants, as well as those which revealed an unusual development of brain after death, contained in the work of a prominent author, the following interesting facts are set forth: The heaviest brains on record (where the statements are to be relied upon) were possessed by a congenital imbecile and an ignorant bricklayer, both of which outweighed those of Cuvier and Abercrombie; while a boy thirteen years of age had five ounces more brain than Daniel Webster or Prof. Agassiz. Such a table shows the utter absurdity of attempting to apply to individuals the rule that the greatest brain power is possessed by the one having the greatest amount of brain substance.

* It has often been noted, that in the presentation of novel subjects, a number of minds have been working in the same direction, while in this unconscious race he who first struggles to the goal of publication wins the title of priority. This seems to have been true of the little current and its reactions I have described. For, having given it forth in full in my paper of March 3, I was both surprised and gratified to find that our distinguished president had also been going over the same ground, and had embodied his results in his very valuable treatise on Medical Electricity, issued in May last. I can best refer to this unexpected, and, to me, very agreeable corroboration of my results, by quoting from Dr. Bartholow's letter to the New York *Medical Record* of May 7:

"In the last three issues of your valuable journal have appeared very interesting communications from Dr. William J. Morton, of New York, on the subject of the Holtz electrical machine.

"In his first paper he anticipated me in the publication of observations on the Holtz machine, which will appear in my Treatise on Medical Electricity, the printing of which has been completed and is now in the binder's hands. At the last moment I was able to append a note to the preface, calling attention to the appearance of Dr. Morton's paper on the subject, which I had announced as novel."

I do not need to refer to the courtesy which dictated this prompt acknowledgment from Dr. Bartholow.

It is certainly extremely satisfactory to find from thus eminent authority this independent confirmation of results, which I had already thought worth while bringing to the notice of the profession.

NEW FLEXIBLE STETHOSCOPE.

THE ordinary form of stethoscope for exploring the pulsations of the heart obliges the physician who uses it to often assume positions that are both fatiguing to himself and annoying to the patient. Dr. Constantine Paul, of Paris, has recently improved this useful apparatus by adding to it the annular copying-glass arrangement which Dr. Roussel invented for his transfuser. This modification has not only made the apparatus more convenient, but has had the effect of increasing the sound and making it remarkably clear, owing to the perfect adherence of the funnel-shaped mouth to the patient's skin. The modified funnel is shown in Fig. 1, and its mode of use in Fig. 2. It is claimed that the indications obtained by this new apparatus are much more precise than those obtained by the use of the old form.

FIG. 1.

FIG. 2.

THE TREATMENT OF TETANUS.

DR. RIA (*Giornale internaz. delle scienze med.*, 1880, p. 7) believes that tetanus consists essentially of an exaggerated reflex irritability of the spinal cord, which may be indifferently caused by traumatisms, toxic influences, or so-called rheumatic action. Since the motor tracts of the cord respond in a morbidly exaggerated manner to all sensitive impressions, the main object of treatment will have to be to lessen sensory excitation; for, if this be accomplished, the cord will gain rest, and thus a return to its normal condition will be made possible. Ria, therefore, emphasizes strict isolation of the patients. They are to be separated from their friends, and to be kept from all possibility of sensory impressions. Even the physician or attendant should exercise great care in his intercourse with the patient, lest the latter be disturbed.

Four cases have been successfully treated by the author. In addition to complete and prolonged isolation, several drugs were employed. Thus, in the first case, in which tetanus developed after an amputation of the thigh, chloroform was applied externally by the use of the atomizer. Nearly three ounces were used daily. A gentle sleep was also maintained by the exhibition of chloral hydrate and morphine. The cure was complete in two weeks. In the second case, that of a youth twenty years old, the same plan of treatment was adopted. But one-sixtieth of a grain of atropine was given in conjunction with the chloral hydrate. A cure took place in twenty days. In the third and fourth cases the external use of chloroform was not enforced, and the last case was treated by bromide of potassium and isolation. This one recovered after forty days.—*Medic. chir. Rundschau, January*, 1881.

PHYSIOLOGY OF VISUAL PURPLE.

DR. WILLIAM C. AYRES, who has devoted special attention to the study of the visual purple of the eye, communicates to the May number of the *New York Medical Journal* an article in which he discusses the physiology of this curious substance. He sums up thus: "We know that the purple is a photo-chemical substance which is sensitive to light, and that its seat is in the outer segments of the rods, whereas it is never found in the cones. The cones, on the other hand, being the only elements found in the fovea centralis, we are forced to the conclusion that distinct vision, both for objects and for colors, is independent of its existence. In the higher classes of animals it is sensitive to light, but in some deep-sea fishes, cephalopods, etc., it has its seat in the rods, but is no longer sensitive to light, although it has the same color as before.

"In another variety of fishes, the black fish, for instance, it is purple in color, but resides in the slender offshoots of the pigment cells which run in between the rods and cones. Where it is not sensitive to light the optical structure of the eye is very defective, and any benefit of a sensitive compound would not be appreciated, and it therefore does its work as a stable pigment. It is an albuminoid compound, and is a secretion of the pigment epithelial cells of the retina, but this secretion is not controlled by any one of the larger nerve trunks which have a part to play in the functions of the eye. We know of no drug which can diminish its secretion, but pilocarpine and muscarine greatly increase it." We, therefore, know what it is and whence it comes. The question now is, what purpose does it serve? We know that a solution of the purple does not destroy the most chemical rays, as those of the violet and ultra-violet light, but, on the contrary, the visual yellow, which is not so deep in color as the purple, cuts off these waves completely. We know also that, when the purple is in excess in the retina, there must be the greatest chemical effect possible, and that if the light come into such an eye the latter cannot see or is overpowered. Thus, when the eye has been for a long time in the dark and comes into light it is dazzled.

Again, when the yellow is in excess, there is a minimum of chemical effect capable of being produced in the retina, and the eye does not see either, as when we pass from a bright light into a darker room. Dr. Ayres, therefore, draws the conclusion that visual purple is "a conservative compound, which is placed in the eye as a matter of protection, and which enables it to perform its duty under the most varied circumstances. In eyes which are not subjected to such variations, it is no longer sensitive to light, but it preserves all of its other characteristics."

NOTE ON THE ISOLATION OF STRYCHNINE.

By ALFRED H. ALLEN.

CHEMISTS who are in the habit of employing ether and chloroform for the separation of alkaloids and other active principles from aqueous liquids, will have noticed a marked difference in their behavior. In the case of ether, the layer of solvent either separates in a few seconds from the aqueous liquid, or can be induced to do so with absolute certainty by adding more ether or by thoroughly cooling the liquid. I have never met with an instance in which ether refused to separate very rapidly, provided that it was used in such quantity that the ethereal layer fully equaled in bulk the lower aqueous stratum.

The behavior of chloroform exhibits a great contrast with that of ether; frequently many hours, and occasionally days, being requisite for its separation from the aqueous layer, and for the coalescence of the chloroform globules. Even then it not unfrequently has a milky appearance, which is rarely if ever noticed in the case of ether.

Some operators, by preference, employ chloroform rather than ether, in cases where either liquid is equally suitable, as it is in the isolation of quinine. This preference is probably generally due to the supposed advantage obtained by the greater density of chloroform, which causes its collection below instead of at the surface of the aqueous layer. In certain other cases, however, there is the far stronger reason that chloroform is a greatly superior solvent for the substance to be extracted. Strychnine forms a notable instance of this, being variously stated to require from 340 to 1,800 parts of ether, but only 7 to 10 parts of chloroform for solution. Nevertheless, and doubtless in consequence of the trouble and delay in the separation of a chloroformic layer, Dr. Tidy and other eminent toxicologists recommend the use of ether instead of chloroform for the isolation of strychnine.

I have myself, till lately, been in the habit of employing ether for the same reason, but now use a solvent which unites a high solvent power for strychnine with the property of ready separation from the aqueous liquid. This consists of a mixture of equal volumes of chloroform and ether. Such a mixture has a density of about 1·10, and hence is sensibly heavier than most aqueous liquids. I have, however, recently employed it with solutions so largely loaded with sugar that the solvent mixture floated on the surface, nevertheless the separation occurred with great facility. In cases where the aqueous liquid approximates very closely in gravity to the solvent, separation can be readily induced by adding water (or better ammonia). Of course, an additional quantity of chloroform or ether may also be added, but if the former be employed in notable excess, the facility of separation is apt to be materially impaired, while if ether be added in considerable quantity the solvent power of the mixture for strychnine is materially reduced. That this last objection, however, has no great weight, is proved by the following results of experiments made by my pupil, Mr. Charles Harrison, to test the point.

One gramme of commercial strychnine was dissolved in acidulated water, and the solution diluted to 100 c.c.

Experiment I.—10 c.c. measure of the above solution = 0·100 gramme strychnine) was treated with excess of ammonia, and the liquid agitated with 10 c.c. of a mixture of equal bulks of chloroform and ether. On drawing off and evaporating the solvent, exactly 0·100 gramme residue was obtained. On again agitating the alkaline liquid with ether-chloroform, an additional weight of 0·004 gramme was extracted.

Experiment II.—A repetition of the above experiment gave 0·097 gramme by the first extraction, and an additional 0·0 9 gramme on reagitating, thus making a total of 0·106 gramme dissolved.

These experiments sufficiently prove that the solubility of recently precipitated strychnine in ether-chloroform is amply sufficient to insure its solution in practice. It will be observed that the weights of the total residues obtained somewhat *exceeded* the original weights of the alkaloid employed. This fact is doubtless due to the strychnine, as dried for a short time at 100° C., retaining some water of combination. I propose to examine this matter more fully. It was found that when the solution of the strychnine in ether-chloroform approached dryness, it was exceedingly apt to decrepitate, thus occasioning loss of alkaloid. This tendency was avoided by adding a few drops of alcohol toward the close of the evaporation. This precaution is only necessary when perfectly pure strychnine is in solution. The small quantity of impurity usually extracted along with the strychnine when the method is used in toxicological investigations, appears to prevent the tendency to decrepitation. In the extraction of strychnine in such practice, I find it convenient to bring the acidulated aqueous liquid to a volume of about 20 c.c., agitate it with ether-chloroform to remove piperine, glucosides, etc., separate, render the liquid strongly alkaline with ammonia, and at once agitate with 30 c.c. of ether-chloroform. The separation usually occurs very rapidly, but may be induced with certainty by adding water or ether in the manner already described.—*The Analyst.*

BOTTCHER'S GAS MOTORS.

THE accompanying Figs., 1 and 2, represent two arrangements of gas motors, invented by Mr. L. A. Böttcher, of Königsberg. In the first of these apparatus ignition is effected by means of a bellows arrangement. The piston of the air pump, C, draws in air through the valve, X, and forces it, on its return movement, through the tube, *k*, and the valve, *y*, into the compression chamber, *k*. At the same time, the piston of the gas pump, D, draws in through the valve, *z*, gas, which it forces through the valve, *z'*, and the tube, *p*, into the chamber, K. A smaller gas-pump, located in front of the pump, D, forces gas through the tube, *g*, into the pressure-regulator. When the pressure becomes too great in the latter, the gas passes through a channel in the piston, *m*, into a chamber which contains a spring, *s*, and returns afterward through the tube, *w*, into the gas conduit. An air-pump, located behind the pump, D, compresses air in the pressure-regulator, N, which is arranged like the gas regulator. These two regulators lead their contents through the tubes, *h* and *u*, to the internal burner, S, as soon as the proper valves are opened. At the beginning of the travel of the motive piston, A, the valve, P, opens, and, soon afterward, the valve, *o*; the gaseous mixture then takes fire in the external burner, *f*, the flame enters toward the burner, S, the valve, *o*, closes, T opens, and the gas contained in the chamber, K, and behind the piston, A, takes fire. During the back travel of the piston, the gases which result from combustion are expelled through the valve, H.

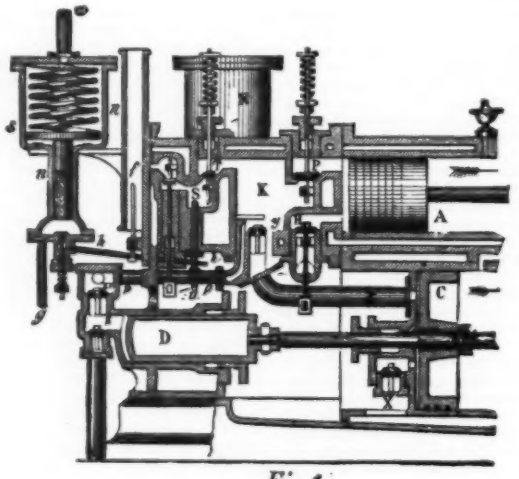


Fig. 1.

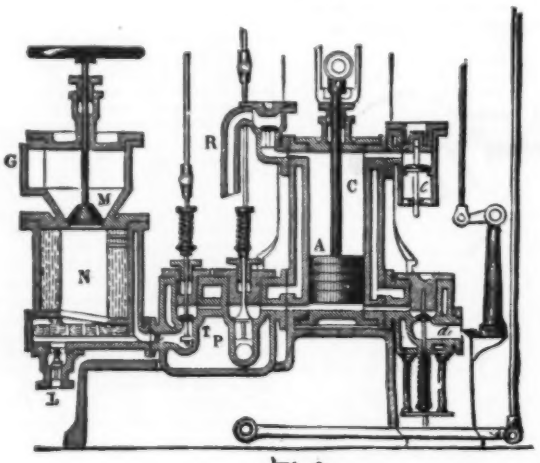


Fig. 2.

BOTTCHER'S GAS MOTORS.

In the apparatus represented in Fig. 2, ignition is effected by means of gases from a special furnace. The motive piston, H, performs on the side, C, the *rôle* of the piston of an air-pump, in the sense that it draws in air through the valve, *c*, and supplies the other side of the piston, A, through the tubes, R and O, and through the valve, P. At the same time, a gas-pump, located behind the piston, A, furnishes the necessary gas through the tube, O, and the valve, P. An air-pump set in motion by the cross-head of the piston, A, draws in air through the valve, L, and forces it into the furnace, N, which is filled with coke, through the reservoir, G, and hopper, M; and the ignited gases which are produced pass from thence through the tube, *n*, and valve, T, and effect the ignition of the gaseous mixture that has entered through the valve, P. The products of combustion are evacuated through the valve, *a*.

SODIUM.—SYMBOL Na.—COMBINING WEIGHT 23.

THIS metal is one of the most abundant in nature, but, like potassium, it is never met with in a free state, but always in a combination with other elements. The compounds of sodium are very numerous and very widely diffused in nature, but the most abundant is the chloride, for this salt occurs in some places in large rock formations called rock-salt, and also in enormous quantities in sea water, which contains about three per cent.; chloride of sodium is also a constituent of river and well waters, and is always present in the secretions of animals, and to a limited extent in the juices of plants also. The preparation of sodium is attended with considerable difficulties on account of its extraordinary affinity for oxygen, although in this respect it is scarcely so strong as potassium. The metal may be obtained by intensely heating a mixture of carbonate of sodium and charcoal, when the sodium is slowly volatilized, and may be condensed, but it must be kept apart from the air or any compound containing oxygen. Sodium is a white lustrous metal, which instantly tarnishes on exposure to the air, and which immediately decomposes water on being placed in contact with that fluid, in this respect resembling potassium, although the chemical action is scarcely so violent; it is soft at the ordinary temperature, and melts at about 195° F., and at a red heat it completely volatilizes, yielding a transparent and colorless vapor; its specific gravity is only 972; it is therefore lighter than water.

Oxides of Sodium.—There are two oxides known, the Monoxide, Na_2O, and the Dioxide, Na_2O_2, but the latter is of but little or no importance. The monoxide, or ordinary oxide of sodium, is formed when the metal is exposed to the action of dry air; it has an extraordinary affinity for water, forming the ordinary hydroxide or caustic soda, NaHO. This compound, which is very soluble and strongly alkaline, is analogous to the caustic potassa referred to in the previous paper, and is used for similar purposes. It is manufactured on a large scale by boiling lime with a solution of carbonate of sodium, and is used extensively in soap-making and other industries. This caustic soda must not be confused with ordinary carbonate—a salt of this metal which is also familiarly but commonly called soda.

Salts of Sodium.—These are both numerous and important, but it will be sufficient for our purpose to refer to only a few of them. The *Chloride*, NaCl, is the source from which all the others are obtained. This salt occurs, as we have previously stated, in large masses in the crust of the earth, in brine springs, and also in sea-water; it is always present in animal secretions, is often met with in river and well waters, and, when there in excessive quantities, constitutes strong evidence of sewage contamination. The presence of this salt in a well-water may be detected by the addition of a few drops of a solution of nitrate of silver, which ought not to produce more than a slight milkiness. In using this test we really detect chlorine, but this element is nearly always associated with sodium in nature, and therefore, the test may be used to identify chloride of sodium. The *Sulphate*, $Na_2SO_4+10H_2O$, commonly called Glauber's salt, also occurs in many well waters. It is manufactured in enormous quantities by the action of sulphuric acid on common salt, and is an intermediate product in our alkali-

works, where it is known as *salt cake*. The *Carbonate* is the most important salt of sodium, and its manufacture constitutes one of the largest industries of this country. In olden times it was prepared on a large scale from *kelp* or *barilla*, that is, the saline ash left after the combustion of sea-plants, but at the present time it is always made from common salt. The details of this process would be out of place here; but the products being of such vast importance, we shall give a brief outline of the changes which take place in the conversion of chloride of sodium into sodium carbonate. The salt is first treated with strong sulphuric acid, by which hydrochloric acid is liberated and sodium sulphate is left behind; this salt is then strongly heated, and constitutes the salt-cake of commerce; subsequently this salt-cake is mixed with coal and limestone, and the mixture is intensely heated in suitably-constructed furnaces; the coal serves to reduce the sulphate to a state of sulphide, and the limestone, or calcium carbonate, then reacts on this newly-formed compound, forming the carbonate of sodium, while the sulphur takes possession of the calcium; the sodium carbonate is then dissolved out from the mass, commonly called *black ash* in commerce, and, by evaporation and recrystallization, the pure soda crystals are eventually obtained. To give some idea of this enormous industry, we may mention that upward of 200,000 tons of common salt are annually converted into carbonate in this country alone. Carbonate of sodium is used in soap making, glass-making, washing, and for purposes too numerous to mention. The *Nitrate*, $NaNO_3$, is found in large beds in Chili and other parts of the world, and from its crystalline structure is generally called cubic niter; it is chiefly used as a fertilizer. Other salts of sodium, such as the phosphate, the bromide, the iodide, the sulphide, the silicate (known as soluble glass), and several others, do not require special mention here.

Tests for Sodium.—All the compounds of sodium are remarkable for their solubility in water, being in most cases more soluble than the corresponding potassium salts; there is, in fact, no reagent that will combine with and precipitate sodium from the solution of its salts; in testing for this metal we have to rely principally on negative evidence. We first prove the absence of, or separate all metals, except potassium and sodium, by methods which will be explained at a later stage of these papers; we then test in the remaining solution for potassium by the methods given in the previous papers, and having proved the absence of potassium we can assume the presence of sodium if any residue be left on evaporation and ignition, or we can test directly for sodium by observing the color a little of the salt imparts to a colorless gas flame; if the smallest quantity of this metal be present a bright yellow color will at once be observed. By the aid of the spectroscope, the presence of very minute quantities of sodium may be detected by the appearance of a bright yellow band, the rest of the spectrum being comparatively black.—*Brewers' Guardian.*

AMMONIUM.—SYMBOL NH_4.—COMBINING WEIGHT 18.

AT this stage it is most convenient to study the properties of the compounds of ammonium, for they bear a strong resemblance to the corresponding potassium and sodium salts. Ammonium is a compound body, but it behaves in every way as a simple element; we know it contains the elements nitrogen and hydrogen, and yet these are so firmly knit together as to give the compound, NH_4, all the characteristics of an elementary body. Whenever a potassium or sodium salt can be produced, it is safe to predict that a corresponding ammonium compound can also be obtained if desired, and in their crystalline form and their general physical and chemical properties, these ammonium salts bear a strong resemblance to the potassium and sodium salts. The compound, NH_4, itself has even been actually isolated, although with considerable difficulty; it can only exist under very high pressure and at very low temperatures, but under suitable conditions it exhibits a metallic luster very similar to the metals potassium and sodium; although ammonium itself is very difficult to isolate, it is comparatively easy to form an amalgam of this hypothetical metal with mercury, by decomposing a sodium amalgam with a solution of ammonium chloride; but this ammonium amalgam also gradually decomposes into mercury, ammonia gas, NH_3, and hydrogen. We have already studied the properties of ammonia when treating of the compounds of nitrogen. We shall therefore here simply describe the principal salts formed by this hypothetical metal, ammonium, and then give the tests by which its presence may be detected. We must here mention that there is an oxide of ammonium corresponding to the monoxides of potassium and sodium; this oxide is formed when ammonia gas is simply passed into water, thus $NH_3+H_2O=NH_4HO$, but the combination is of the weakest character, for it only requires the application of a gentle heat to drive off the whole of the ammonia gas again.

Salts of Ammonium.—One of the most common is the *Chloride*, NH_4Cl, or sal-ammoniac, as it is frequently called; this salt is prepared by neutralizing gas liquor with hydrochloric acid, and subsequently concentrating the solution until the salt crystallizes out; it is usually purified by one or more sublimations. The *Sulphate*, $(NH_4)_2SO_4$, is prepared in a manner similar to the chloride, using sulphuric acid instead of hydrochloric acid; it is used to an enormous extent as a fertilizer, and also in the production of alum, for this purpose replacing sulphate of potassium which at one time used to be exclusively used. The *Carbonate*, $(NH_4)_2CO_3$, is a volatile salt, which can, however, be obtained in a solid form. The *Sulphide*, $(NH_4)_2S$, is a yellow liquid, possessing a most offensive odor; it is largely used by chemists for distinguishing the metals from each other. There are many other salts of ammonium, some of which have important uses in the arts and medicine, but their enumeration is scarcely necessary here; it is sufficient to say that wherever a potassium or sodium salt can be formed a corresponding ammonium salt can also be obtained if desired.

Tests for Ammonium.—Nearly all the salts of ammonium are readily soluble in water, the only exceptions being the same as with potassium, the tartrate and the double chloride of ammonium and platinum; tartaric acid and platinic chloride are therefore tests for ammonium. It is easy to distinguish ammonium from potassium by the former's volatility, and the presence of ammonium in a salt can be easily detected by adding a little lime or caustic alkali, when the strong-smelling and pungent ammoniacal gas is rapidly liberated. Very minute quantities of ammonium compounds may be detected by means of the Nessler test, according to the method described in a previous stage of these papers, when we were discussing the combination of nitrogen with hydrogen.—*Brewers' Guardian.*

ADULTERATION OF FOODS IN FRANCE.

THE Paris correspondent of the New York *Times* gives the following as a brief summary of the report just published concerning the results of analyses made at the laboratory recently installed at the Prefecture of Police of the Department of the Seine. The details are eloquent and especially edifying:

Out of 123 samples of wines examined, 3 only were found to be of genuine grape juice; the remaining 120 were pronounced deleterious falsifications, in which were litharge, tannin, lime, chalk, the carbonates of soda and potash, with coloring matter taken from coal tar or organic remains of which the name alone is enough to nauseate. Three ciders out of 3, 12 vinegars out of 12, showed large proportions of chlorohydric, sulphuric, nitric, tartaric, and oxalic acids. Out of 20 milks, 15 were compositions of starch, dextrine, fish glue, and gum-adraganthe. In some not one drop of milk could be found. Its absence was supplied by an emulsion of hemp seed with an addition of animals' brains and blood serum. Veal suet combined with chalk and the carbonate and acetate of lead was the base of the butter samples. The peculiar taste of certain kinds of cheese, for which they are particularly prized by connoisseurs, was obtained by using an unmentionable liquid excrescence in their manufacture; in others the venders had not hesitated at aspersions of their merchandise with a poisonous liquid known as *mort aux mouches*, or fly bane, in order to keep off insects. Decoctions of bitter vegetable substances, such as lichen, box-wood, poppies, guaiacum, hyoscyamus, belladonna, nux vomica, etc., were substituted for hops and barley in seven beers out of ten. Nearly every one of the numerous packets of coffee submitted to M. C. Girard contained as a base torrefied coffee grounds purchased from the restaurants mixed with red clay, mahogany sawdust, and baked horses' livers reduced to a fine powder, while even the chiccory, which is commonly supposed to be the principal bogus element of coffee as sold by grocers, was ascertained to be falsified with brick-dust, ocher, rotten figs, and animal black. As to chocolate, including specimens sold at 2f. the pound, it is nothing but a mixture of ochrous clay, grated toast, sawdust, and damaged cocoa, sweetened with coarse brown, instead of fine white, sugar. The so-called tin-foil with which its cakes are enveloped contains 75 per cent of lead.

BUTTER-MAKING.

DR. VOELCKER, the eminent chemist of the Royal Agricultural Society of England, delivered a series of four lectures on the "Principles of Butter-Making" at the recent annual exhibition of the society at Derby. We condense the following paragraphs from reports of the lectures:

"Cream consists of a certain proportion of water and fatty matters, and a small proportion of casein. If this latter element were absent, the principal difficulties in the way of butter-making would be at once overcome, because it is due to the rapidity with which casein turns sour that butter obtains the rancid taste which we sometimes detect. If by any means we could separate the fatty matter from this casein or curd matter, we should get excellent butter; and it is on this account that I believe dairy farmers will never obtain the first quality butter from whole milk, certainly not the same quality as that which is obtainable from cream. The composition of cream varies greatly, and the same remark applies to the fatty matters of which it is constituted. This circumstance I attribute in a very large degree to the feeding of the cows. Nobody, for instance, can feel any astonishment that when cows are fed upon turnips, swedes, and mangels, there is a more or less disagreeable flavor in the butter made from the milk of these cows. In my opinion, the best flavored butter is made from the milk of cows fed, not upon rich pastures but upon what are generally considered poor pastures; that is to say, those with scanty herbage, such as is to be found upon the hilly land which abounds in this country. By rich pastures I mean pastures which produce a large bulk of grass, but which are not composed of a great variety of herbage. The richer the quality of the cream, the richer will be the quality of the butter made from it.

"It has been said, with a good deal of truth, that by overmanuring pasture land we reduce the fine quality of the butter made from the milk of cows fed upon such pasture. My belief is that the finest quality of butter is produced from pasture which contains a great variety of herbs, some of which might even be ranked as weeds. The question is, Can ordinary pasture produce first quality butter? and I answer, 'Decidedly, if you take proper precautions to prevent the cream turning sour before it is churned.' This sourness, let me repeat, is the great hinderance in making high-class butter. Many persons deem this a small matter, and unconsciously allow the cream to get somewhat sour before making butter; but if you desire to produce good, sweet, keeping butter, you must churn cream as sweet as possible.

"But how are you to prevent cream getting sour? In the first place, you must carefully look after all the people employed in and about the dairy, to see that they always have the importance of cleanliness before their eyes; and above all see that those who milk the cows do so with clean hands. Secondly, you should be sure that the cows are perfectly 'stripped,' because if this is not done it is the means of sowing the germ of rancidity. Then, when the milk is drawn from the cow, it ought to be cooled down directly to about 55°, so as to take the animal heat from it.

"As to the question of shallow or deep pans for 'setting' for cream, I am an advocate for the use of deep ones. After being filled with milk, these pans should be placed in a vessel containing water—ordinary pump water answers well—for twelve hours; or, if the milk is extra warm, a little ice may be used, and this would result in a large proportion of cream rising. In order to prevent rancidity, it is very important that the cream should be churned at once. In small dairies, however, this is impracticable, and in such cases every endeavor should be made to prevent the casein from turning.

And here let me say, do not churn too quickly. Do not be in too great a hurry and turn irregularly, because if you do failure will almost certainly result. Turn steadily, at about forty-five or fifty revolutions per minute. As soon as butter comes—and this you can tell by the noise—it is time to stop the churn and deal with the butter kernels. Strain off the buttermilk, put some cold water into the churn, and turn it again two or three times; this will have the effect of washing the butter. Perhaps the best way is to incorporate the smallest quantity of salt, or salt water, into the churn, so as to distribute the salt evenly among the butter. I do not recommend too frequent washing, as this only results in the butter losing that fine natural flavor which it should possess. After each process of butter-making, the churn and other utensils should be cleansed with boiling-hot water. In butter-making everything depends upon scrupulous cleanliness, the use of plenty of hot water, or steam if it is available, followed by cold water.

"One of the first necessities in the making of good butter is to have at command an abundance of cold water—spring water if possible, or pump water—so as to get rid of the animal heat as soon as the milk comes from the cow. By this means, also, you get rid of the animal flavor. Whenever you have the means of setting milk for cream, I strongly advise you to do so. If you take care to keep cream as closely as possible to a temperature of 55° to 57° Fahr., you will not only get a larger produce of butter, but also butter of a better flavor. By using deep pans, and in hot weather putting a lump or two of ice in the vessel of water in which the pans are placed to preserve the temperature below 58°, I am ready to guarantee that cream will keep without turning sour for a period of at least eighteen hours. Butter should always be made from perfectly sweet cream.

"In the art of butter-making chemistry is not required. It is a simple mechanical operation. Some people are of opinion that a certain degree of sourness in cream is necessary in order to obtain good butter. My experience has taught me differently, and I denounce the sour-cream theory as radically wrong. There is an opinion that the longer cream continues cold the worse it becomes. Sometimes a novelty, if carefully investigated, proves to be far more useful when thoroughly worked out and practically tested than the experience of the man who has been going on in his own way for twenty years. A great many such men maintain at the present time that the best quality of butter can only be made if cream is allowed to turn a little sour. This is a great mistake. The sweeter the cream, the better the butter will turn out, other circumstances being equal.

"Milk is a mechanical mixture, not a chemical compound. It is well to remember this, because it is not by chemical means that we separate cream from skim milk, but purely by mechanical means.

"The cream globules rise to the surface, and by proper management the cream is taken away from the skim milk. In this way we obtain the cream perfectly sweet, and provided the food given to the cows is of such a nature as to produce sweet and not 'turnipy' cream, we can obtain excellent butter by churning it properly. Although my profession is that of a chemist, I would impress upon you that the less chemicals you use, or the less you attempt to meddle with chemical agencies in the separation of butter from the cream, the better will be the result. If you pour off the buttermilk as soon as the butter comes, you will have butter much more free from the cheesy or curdy envelope which originally encased it in the creamy globule. And you will never make first-rate butter unless you preserve a regular temperature in churning. The temperature should never rise above 60°, it should be rather below than otherwise. I am no advocate of all these beautiful air churns, and complicated contrivances. You do not want them. In a good churn you simply require an implement which enables you to churn sufficiently without overdoing it. All churns should be so constructed as to be easily cleaned. The requisites for successful butter-making are, a well-constructed dairy, not subject to great fluctuations of temperature; a dry floor, perfect cleanliness, appliances for introducing hot or cold water, or steam; and in the last place, washing it moderately, and salting it in the churn. If you want to make first-rate, firm, fresh butter, there is no secret; no great chemical skill is required, only ordinary attention to a few simple principles; and by observing them I warrant that you obtain for your butter a better price."

FLESH AND FAT PRODUCERS.

THE *American Agriculturist* makes up from the published analyses of the most eminent agricultural chemists the following table exhibiting the relative nutritive value of different feeds. It corresponds strictly with the experience of many noted English feeders, and is probably the most trustworthy information yet collected in so compact a form:

	Flesh.	Fat.
Turnips	1	5
Rutabagas	1	7
Carrots	1	7
Mangels and kohlrabi	2	8
Straw	3	16
Potatoes	2	17
Brewers' grain	5½	18
Wheat and barley	12	67
Dried brewers' grain	16	70
Earth nut cake	20	40
Beans (English field)	22	46
Linseed	23	92
Rice meal	6½	77
Locust beans	7	72
Hay (early cut)	8	50
Millet (seed)	8	76
Buckwheat	9	60
Malt	9	76
Rye	11	72
Oats	12	63
Corn	12	68
Palm nut meal	18	98
Tares (seed)	27½	57
Linseed cake	28	56
Bran and coarse mill stuff	31	54
Rape cake	31	53
Decorticated earth nut cake	39	45
Decorticated cotton seed cake	41	77

It will be seen from the above that cotton seed meal has no superior as a flesh-former, and that for fattening it is better than every other article of stock feed. In a very short time it has established itself, both in this country and in Europe, as the food for beef cattle and for dairy purposes.

SWEENY.

THE vulgar term sweeny is applied to a real or imaginary wasting of the muscles of the extremities, and mostly referred to as being located in the shoulder or about the crupper. It is commonly regarded as a special evil, and all sorts of cruel practices and nostrums are resorted to for its cure. The cause or causes of a generally negative result of the treatment applied is simply this, that sweeny, or more properly speaking, wasting or atrophy of the muscles of the horse's limb, is, in the plurality of cases, merely one of the results of chronic disease of some part of the limb, such as a painful corn, navicular disease, and contracted feet, or ringbone, spavin, etc. If a cure of these ailments is possible the so-called sweeny will either gradually disappear in the course of time or will yield to treatment; otherwise the cure

of sweeny will prove a failure. In young horses, sweeny, or wasting of the muscles of the shoulder, is often a consequence of unsteady pulling with an ill-fitting collar. In such a case, relieve the animal from work, and apply for some time, once or twice a day, a portion of equal parts of tincture of cantharides and oil of turpentine. The contents of the bottle should be shaken while applying the same. Liberty outdoors, on pasture, will be of additional benefit. Subsequently, give only light work in breast harness or in a soft padded, well fitting collar, until the animal becomes used to pulling.—*National Live Stock Journal.*

NATURAL AND INDUSTRIAL HISTORY OF THE WHITE PINE IN MICHIGAN.

The following interesting paper, read by Mr. William Hosea Ballou, of Evanston, Ill., before the American Association for the Advancement of Science, at Cincinnati, August 19, is published by the author's permission:

Forty six years ago, the pine lumber industry of Michigan had its origin on the banks of the Saginaw River. From that time to the present, the denudation of timber has increased in that State and other pine areas to such an extent that, within the next decade, the use of such material as a commercial product must pass out of existence, unless preventive steps are taken. Already the producer is beginning to look with genuine alarm for such aid as science may extend to avert a calamity which certainly threatens an industry, the capital invested in which would have paid the expenses of the late civil war. It therefore devolves upon us to discuss not only the enemies of the pine tree which nature herself has inaugurated, but also the statistics of the destruction by the more formidable consumer, man. This paper is necessarily confined to the white pine, as it was, and to-day is, in the State of Michigan.

The first thought suggested is relative to the origin of the white pine forests. From whence comes the species which so strictly confines itself to its own peculiar territory? The oak, and most other trees, are naturally reproductive, and young trees are equally prolific in their growth on the soil where the first forest was leveled to the ground. They may be transplanted on almost any territory, and without any special care, and speedily grow up to a state of usefulness to man. Not so with white pine. It is now an almost undisputed fact that it will not reproduce itself on the parent soil. When transplanted elsewhere, its development is marked with early decay in so many instances as to disparage the work. Furthermore, it is beset at once with the same host of enemies common to it on its indigenous soil.

For some years past my attention has been directed to facts which may have bearing on the question under consideration. The pine of the level country east of the Rocky Mountains seems to have its best growth in proximity to the lake region. I have noticed that frequently where a lake recedes, leaving a sandy beach, evergreens, the juniper pines, etc., are very apt to spring up. Within the memory of man, a wide sand-beach near Waukegan, on Lake Michigan, has been formed, and on this area a miniature white pine forest has appeared, and thrives. On some lone islands in Lake Erie, of evident recent formation, called the "East Sister," the "Old Hen," etc., I observed, several years since, a similar phenomenon had occurred. These and other facts point to a recent origin of the pine forests under consideration, which may not have been in existence at the time of the landing of Columbus. This fact is more apparent when it is stated that the average age of the pine is less than three hundred years, in this country, and the other fact is reiterated that it does not produce on the same soil. The present forests, then, must have been the natural successors to some other species which had exhausted that vitality of the soil necessary to their existence. Such phenomena is so familiar to naturalists that further elaboration is unnecessary. It matters not whether the seeds were blown there by the winds, or lay dormant in the soil until their turn, or, indeed, what the speculation concerning them is, so long as the facts are inaccessible; certain it is that the origin of the pine forests in Michigan is a matter of several centuries ago.

The next question of importance is reproduction. Answers to queries submitted to over one hundred practical lumbermen, as well as careful observation, make positive the fact that the reproduction of the white pine on parent soil is impossible as a commercial success. So far as the pine is concerned, the most important fact has relation to the exhaustion of that vitality of the soil necessary to this species. Other causes have been advanced, to the neglect of this, which plainly do not bear on the subject. Were reproduction successful—and here is the great practical proof of the matter—my one hundred informants say that, long ago, forests would have been cultivated to replace those now a fact of the past.

The enemies of the white pine are numerous. The average of the data I have gathered tends to show that the pine forests began to decay before one-half of the trees were matured. The causes of such decay are the growth of "punk," or rot, "wind-shakes," and "loose knots." Insects do not originate, but hasten decay, as will be shown. The punk is a rot, sometimes a foot in diameter, which appears in a lump on the side of the tree, eating into its vitals. It is due to more than one cause. Opinions of writers vary on this subject, all of whom argue in behalf of a special cause. I have carefully examined all of these claims, but am convinced, from extended observation, that anything which affects the vitality of a tree will produce punk. It matters not whether the tree becomes wind-shaken, or the soil exhausts, or a knot penetrates to the heart, or what befalls it when alive, punk is sure to become the secondary condition, followed by destruction.

Enemy number two is the black knot. This is a loose knot, black in color, which, when the tree is sawed, drops out of the board, making it defective. It is caused by imperfect growth. If there is not sufficient nourishment at the roots to support the limb, it grows imperfectly, and its inner termination works toward the heart, as if to suck sap from the vitals. This brings on loose layers, and subsequent decay.

A wind-shake is one of the most exasperating defects of lumber. It is noticeable in a board, the layers of which separate, or split, in a triangular form when the sawing takes place. It occurs generally on the butt of the tree, and is caused by the force of the wind when the tree is standing, and by frost when the log rests in the mill yard. Opinions vary on this latter point.

There are other enemies of the pine, all of which deserve attention just at this time, when commerce must begin to economize, and obviate, so far as possible, all difficulties in the way of making the product supply the demand.

The first of these is fire. All parties agree that from one-third to one-half of the timber product is destroyed by this agent. Fires, where they occur, follow clearings, but often penetrate the dense forests, sometimes covering an area of a hundred square miles. It is impossible to secure data on this subject, because more or less lumber is saved from the wreck. A pine tree that has been scorched is utilized the succeeding year, or the worms destroy it.

Insects are very destructive, the pine weevil, *Tomicus xylographus*,* being a foremost agent. These attack a sound tree, but not a live one. If any one will take the trouble to enter a great log yard at dusk, these creatures will be heard at work, the united sound of which is like the roar of wind or water. The grub goes through a log in a crooked line, leaving a passage way which greatly depreciates the value of the timber.

There is a pin worm, the scientific name of which has escaped me, that bores its way straight to the heart, leaving a round, black passage the size of a pin-head. These are the only insects which lumbermen take into account in Michigan, I believe.

The white pine does not furnish so rich a pitch as the yellow pine of the South. It has but little market value. It is sometimes gathered for medicinal purposes, melted, cut with spirits, and used for throat diseases. Some people use it for ague, but so much whisky is mixed with it that the scientist pauses on the threshold of doubts as to whether the pitch is used to save the whisky, or the liquid to get the benefit of the pitch.

A pine tree grows from 90 to 160 feet in height, the average being 125 feet. A log sixteen feet long will average 250 feet of lumber, though one log has been known to produce 2,500 feet. The diameter of an average log is thirty inches; the maxium is six feet. A pine tree begins to branch two-thirds of the way to the top, often branching at the top only.

The facts give rise to a general formula, that a tree is no greater than its roots. The expanse surface of roots of the pine correspond closely to that of its height and outer surface. Although much crowded in a dense forest, the roots of an overturned tree have been known to yield a surface of forty feet square, 1,600 square feet. Pines grow usually on high ground, in sandy soil, but best when the latter is mixed with clay.

The waste branches of the pine tree are not utilized to any extent except as fuel. Pine sawdust is now converted into paper pulp extensively, and is used in packing glassware, and in other ways is a commodity.

The heart of the pine resists to the last all injurious causes which operate on the outer layers. Windfalls are severe agents of destruction, as speedy decay follows.

The following items are relative to the pine lumber industries of Michigan. I am largely the debtor of Mr. G. W. Hotchkiss, secretary of the Lumberman's Exchange, Chicago, to the files of the *Northwestern Lumberman*, Mr. J. W. Longyear, of Marquette, E. D. Galloway, Howell, Mich., and others, for the information here given.

In 1835, there were 150,000,000,000 feet of pine timber on 20,000,000 acres of land. Since that time 115,000,000,000 feet have been cut. In the northern peninsula there now stand 6,000,000,000 feet of timber on 4,000,000 acres. On the southern peninsula are 29,000,000,000 feet on 6,571,000 acres. This leaves a total of 35,000,000,000 feet on 10,571,000 acres. Some 5,000,000,000 feet are now annually taken, so that in seven years the supply will be exhausted.

In this industry (which, of course, must include lumber of all kinds) there are in 600 mills, 150 gang saws, 600 circular saws, 100 mulays and 500 edgers, with a total capacity of 5,000,000,000 feet per annum, and a total value of $11,750,000. There are 800 vessels engaged in the transportation of this lumber, occupying 4,800 men, and valued at $4,000,000. In the woods in winter are 50,000 men at work, and 20,000 in the saw-mills in summer. There are 30,000 animals thus engaged, one-third of which are oxen, and the remainder horses. There is a total of 75,000 men and animals; a total capital invested in mills of $111,750,000. The lumber taken from the forests since 1835 has sold for about $1,500,000,000.

The ancient lower limit of the white pine belt extended from Grand Haven to Port Huron, dipping on the west side of the State to Kalamazoo. The whole pine area now comprises 288 townships in eighteen counties in the lower peninsula, embracing 10,268 square miles, or 6,571,520 acres; and in the upper peninsula, 179 townships or 4,124,160 acres.

It almost seems like a task of despair to hope to ever raise forests for another such enormous production. Science will doubtless devise other materials as a substitute. Indeed, I have been shown a material manufactured in the West, in the shape of a board, one inch thick, made from wheat straw, which can be colored to represent any lumber now known so accurately as to deceive the eye. The inventor manufactures 2,000 square feet from a ton of straw. It is more durable and much cheaper than lumber. As a parallel to the use of paper wheels, Mr. Pullman is now said to be finishing off three palace cars in this material. The limit of its manufacture will depend only on the production of wheat straw.

* Entomologists of the Association believed this to be some other species, contrary to the opinion of A. S. Packard, of the U. S. Entomological Commission, and myself. If some one will send me specimens of insects destructive to pine, I will identify them, and report in these columns.

A LIFE-TIME WITH ROSES.

The Rev. S. Reynolds Hole, or Canon Hole, as he is more commonly called, as President of the National Rose Society of Great Britain, delivered an address at its exhibition in July last. The whole of it is spicy, but only some parts of it can be given here. After a pleasant introduction he said that "after thirty-five years of enthusiastic love among the roses, thirty-five years of daily observation, copious inquiry, careful culture, I come to communicate results. I feel much as I felt when, traveling one day on the underground rail, I misunderstood directions, and, crossing the wrong bridge, found myself, after forty minutes' absence, at the station from which I started. I go back thirty-five years, and though since that distant date I have grown roses by the thousands, and instituted rose shows, and won silver cups by the score, and walked through miles of roses as a judge, and written a book about roses, I am here, after all, to confess that my knowledge, as compared with my ignorance, is as a penny squib to a comet, as an unfledged tomtit to a flying eagle; that I have made mistakes innumerable; that I have planted too deep and too shallow, pruned too long and too short, too early and too late, manured too much and too little, exhibited flowers that were superannuated, and flowers which had not arrived at rosehood; that I have succeeded where I expected to fail, and failed where I hoped to succeed. But you will begin to murmur internally, 'Surely this man is not come all the way to Sheffield to tell us that he knows nothing,' if not to express your remonstrance, as when the blue ox of Artemus Ward rubbed some of his paint off against the central pole of the exhibition tent, and the spectators openly declared that 'that sort of thing would not go down in their enlightened district.' I hear you say, 'Let us have the results of your experience, however small they may be;' as when an Oxford examiner, being told by an undergraduate who had failed dismally, that he had not been questioned on the subjects which he knew the best, tore off a tiny scrap of paper before him, and handed it to the plaintiff, saying, 'Be so good as to write what you know on that piece of paper.'

"Gladly and unreservedly I offer you the result of my experience with regard to the cultivation of the rose. In the first place, as I have already intimated, your heart must be in your enterprise. There is a good deal of 'mere verbiage'—frothy effervescence, humbug—in some of those gushing expressions of delight and admiration which we hear so often. 'Oh, Canon Hole, what a heavenly duck of a rose!' 'Well, it's not quite in its best form as you see it there.' 'No; but isn't it too awfully jollily not quite?' Misled on one occasion by these professions of adoration, I presented a lady with a lovely rose, and, not long after, when she became interested upon some other topic, she began to pick off the petals! I stood astounded, like Launcelot when

> ——the Queen
> Brake from the vast, oriel embowered vine
> Leaf after leaf, and tore, and cast them off,
> Till all the place she stood whereon was green;

and then I remembered I had business in another direction, and I went to it, a sadder and a wiser man.

"Supposing the love to be sincere and the intentions hearty, what next? Pure air. I have seen good roses, it is true, which were grown within three miles and a half of St. Paul's Cathedral, and were exhibited at the first Crystal Palace rose show by the grower, my friend, Mr. Shirley Hibberd. But the disappointments are so many, and the successes so few, that I should say to all persons proposing to grow roses within six miles of a smoky manufacturing town or city, as *Punch* said to all persons about to marry—'Don't!' This pure air must nimbly and sweetly recommend itself to the rose, but it must not visit her cheek too roughly. Roses must have shelter, but not shade—free trade in sunshine, but protection from storms. They should have a screen of shrubs or of walls, but they must not be placed too near it. They dislike wind, and, as all things else which are fresh and clean, from a fair reputation to a leg of mutton, they must not be blown upon.

"The bush is beyond a doubt the prettiest form in which we can grow the rose, and this we obtain by grafting, or budding, or by striking cuttings from the parent plant. You have all beauty of flower, foliage, and form under your eye, with this additional and supreme advantage over the standard tree, that, when you have placed a thick blanket—that is, a good covering of straw manure—over your sleeping beauties toward the end of November, you may go to bed with the thermometer at zero and dream of rose shows. A bed of these dwarf roses, with the long laterals pegged down one year, and blooming from laterals of their own the next, is one of the most charming sights in a garden. The bed should be round or oval, raised in the center, and with large surrounding of well-kept grass.

"What sorts, what varieties of roses shall we grow? All sorts. Single and double, large and small. And in all forms—trailing along banks or towering on walls; making fountains, arches, and aisles; glimmering in plantations like 'stars which in earth's firmament do shine;' rising from beds of shrubs, or circling them, as we saw the old China rose the other day in the gardens of the Crystal Palace. He is no true rosarian who does not love all the roses; and some of you may have read the public and indignant protest which I have made against an accusation which has been brought against us, that, because we believe those roses which you have seen to-day to be of all the most beautiful, we are indifferent as to the other varieties, and it has been suggested that, because the National Rose Society proposes to publish a catalogue of roses most suitable for exhibition, it may be necessary to establish a rival institution to watch over the interests of roses for the garden only. I think—and it is such a happy thought as even Burnand himself never excogitated—that I know more rosarians, and more of the rosarian mind, than any other living man, and what I know most surely is this, that he who loves one rose loves them all. Only the other day, when I had left in the garden some of the loveliest roses I ever grew, and was on my way to the station, that I might adjudicate next day at the Crystal Palace aforesaid, I surprised a servant who was with me by stopping my dogcart to gaze at a garland of dog roses drooping down the roadside hedge, and I believe that most of my brethren would have been as charmed as I was.

"I am constrained to confess that H. M. the Queen of Flowers is not refined in the matter of diet. She is a gross feeder, and when I think of the quality and quantity of her favorite food, I recall a passage in the letters of Charles Kirkpatrick Sharpe: 'I met Mrs. Siddons at dinner just before the death of her spouse. It was at Walter Scott's, and you cannot imagine how it annoyed me to behold Belvidera guzzle boiled beef and mustard, swill porter, take huge pinches of snuff, and laugh till she made the whole room shake again.' So does the prima donna of our stage; so does the rose rejoice in strong sustenance, solid and fluid, with occasional pinches of tobacco powder and lac sulphuris; but, as with Mrs. Siddons, they who had dined with her forgot the beef, and the beer, and 'the pungent grains of titillating dust' when she appeared in all her power as an artist. So when we see the rose in her beauty, we forget the midden and the tank. I go further than this in my devotion to the ladye of my love, and her likes are mine also. However unsightly to the eye, or unsavory to the nose, they seem to say, like the earth in the Persian fable, 'I am not the rose; but cherish me, for we have dwelt together;' and they do not appeal in vain.

"What is the main result of my long and varied experience in this matter? It is that I find myself as upon the Metropolitan Railway at the place whence I came. The system which I followed thirty years ago I propose to follow so long as I am attached to this machine, and have the happiness of growing roses—namely, to give them a liberal supply of farmyard manure about the third week in November, which will act both as food and clothing also; to dig this in early in March, and afterward to apply occasionally liquid from the tank, or some other of the refreshments to which I have referred. But the young rosarian must not place his main reliance on these enrichments, indispensable as they are admitted to be; he must believe in the manure heap, but must regard his soil and its cultivation as of primary and perpetual importance. Success in rose culture can only be obtained in accordance with the universal and eternal law—you must work to win. There must be

draining and digging, hoeing and weeding, and a watchful loving patience, which defends the rose from its enemies, as well as surrounds it with friends. Hence the paucity of rosarians worthy of the title. There are numbers who gush at shows, take down the names give orders, plant rose trees, but who never stoop to pull up a weed, and as for extracting the grub from his leafy bower and handling him somewhat severely between finger and thumb, why that is 'simply disgusting!' These are the sort of people who think when they have signed a check that roses should spring up around them about the size of punch-bowls, and that thankful nightingales should sing in them night and day. Somehow this firework won't go off. 'O, yer don't want to go into business, don't yer?' said an angry father to his lazy and loutish son. 'Yer want an appointment in the Post horfice, do yer? Post horfice, indeed! Why, all you're fit for is to stand outside with your tongue hout for people to wet their stamps against!' He who would grow roses must not be afraid of dirtying his fingers—of resembling that clergyman of whom Sidney Smith said, that he 'seemed to have a good deal of his glebe on his own hands;' or of a likeness to Martin Burney, to whom Charles Lamb remarked over a rubber, 'O, Martin, Martin, if dirt were trumps, what a hand you'd have!'"

A REMARKABLE HAILSTORM IN FRANCE.

ON the 18th of June, 1881, a hailstorm traversed the department of Loiret in the general direction of S. W. to N. E.; and the observations upon it which follow were made at La Chapelle-Saint-Mesmin, near Orleans.

The 18th day of June had been a particularly hot and suffocating one—the thermometograph marking a maximum temperature of 30° R. The storm made its appearance on the horizon toward half-past three o'clock in the afternoon; The first peals of thunder were heard at about four o'clock, and were immediately followed by a few exceedingly large drops of rain. At ten minutes past four the state of the heavens was very curious and interesting. The whole S.W. portion of the horizon was bounded by a thick, dark-gray curtain, which was formed by hail that was falling in the distance and approaching with rapidity. A little above this curtain there was observed an irregular band of clouds of a deep copper color, through which continuously played flashes of lightning. Toward the S. E., in the region of the zenith, a large hole was made through the mass of the storm-cloud, and the edges of which seemed to be the seat of partial movements and rapid changes of form, the general mass appearing to be possessed of a rapid gyrating motion. There were counted in this region four very distinct cloud-strata, which, beginning with the lowermost and proceeding upward, were: (1) A stratum of large, black clouds, having an apparent rectilinear motion from N. E. to S. W.; (2) a less dark stratum, rapidly moving from N. W. to S. E.; (3) iron-gray clouds coming from the S. W. and directing themselves toward the N. E.; (4) a uniform and very elevated sheet of luminous and grayish vapors, in which there could be perceived no apparent movement.

During the entire duration of the storm, the wind on land was blowing from N. W. to. S. E. The diagram annexed (Fig. 9) will give an idea of this state of things, which were visible up to a quarter past four o'clock. At that moment the curtain of hail suddenly entered all points of the horizon, and, after a few crackling forerunners, the hailstones reached the earth. These were so numerous and so close together that the light of day was nearly intercepted, and the noise that they made in falling completely drowned that of the thunder. This shower lasted without interruption, and without a drop of water accompanying it, for ten minutes, and was succeeded by a torrent of rain.

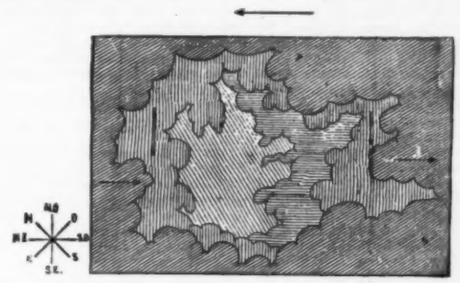


FIG. 9.—DIAGRAM SHOWING THE ARRANGEMENT AND DIRECTION OF MOTION OF THE DIFFERENT STRATA OF CLOUDS BEFORE THE HAILSTORM.

The hailstones which fell were not very large, the largest weighing on an average 75, 85, and 110 grains. There were a few found which weighed 230 grains, but these were exceptional. Their forms were very varied, as is shown in Figs. 1 to 7. They may be referred to two very distinct types:

First Type.—Those having concentric zones, alternately opaque and transparent, the central nucleus and the external surface being always opaque. This type includes two principal kinds: (1) the *spheroidal*, represented by forms, some of which were almost spherical, and others more or less flattened, according to the axis of rotation (some of these reached the ground broken, and showing a plane surface, as seen in Fig. 7); (2) the *conoidal*, which were quite rare, but of which, nevertheless, I was able to sketch a beautiful specimen (Fig. 6). This form must be attributed to the segmentation of a spherical hailstone into a certain number of pyramids, whose angles have been afterwards blunted by the addition of new layers of ice, or by superficial melting.

Second Type.—Transparent hailstones having an opaque center. Almost all these forms were crystalline, or at least beset with rough points resembling crystals. This type likewise includes several species. (1) The *spheroidal*, embracing forms more or less spherical, with a surface as if tuberculated by the presence of crystalline projections with blunt angles, giving them the appearance of mulberries (Fig. 3); (2) the *discoidal*, represented by disks of varying thickness, whose irregular edges were studded with crystalline points, and from the central nucleus of which spread out a large number of whitish rays; (3) the *irregular*, comprising a large number of hailstones which it was impossible to refer to any definite geometrica. form.

I have been enabled to examine with a polarizing microscope a few sections of hailstones, and have made a characteristic drawing of one of them, which is shown in Fig. 8. The figure is a reduction of a drawing made under a magnification of 30 diameters. The hailstone represented is a spheroidal one of the first type. The transparent zones in it appear to be composed of a great number of small surfaces having irregular and polygonal contours, elongated in the direction of the rays. All these surfaces were tinted with different colors. I have already found this same aspect in the frost sheet of January 22, 1879, and afterward in certain ices formed during the month of December of the same year.

The same texture was clearly visible in the opaque portions of the hailstone; but these were characterized by the presence of an innumerable quantity of air-bubbles forming, as it were, a seed-bed from which detached themselves regular and parallel rows of much larger bubbles. I have counted as many as seven of them in one very small opaque band. Other isolated rows were found in abundance in the transparent portions.

The fall of hail, of the 18th of June, was accompanied by some remarkable phenomena.

The hailstones fell with a very moderate velocity; but as soon as they approached a large and resistant body they fell on it with great force. This peculiarity has since been verified by the following almost incredible fact: On the one hand, vegetation suffered but little—vines being scarcely touched and cereals remaining nearly intact; but, on the other hand, dwelling houses were strongly put to the proof, all windows exposed to the storm being broken and the very walls being riddled with holes as if they had received a discharge of grapeshot. The hailstones which entered apartments rebounded with violence, and several times in succession, against the walls, in the manner of electrified bodies; and, of one of these, among others, I was enabled to observe the capricious evolutions.

It was a spheroidal hailstone of the first type. It had struck the soil of an arcade and rolled off into a passage way, where it became entangled; when, suddenly it rebounded upward, and coming in contact with the partition above it was sent back to its starting point, where it began to spin around rapidly like a top. I had leisure to study this phenomenon, which lasted for five or six seconds, at the expiration of which the rotation suddenly ceased, and the hailstone thereafter became immovable.

I close in mentioning the firing of a house by lightning, and in remarking that the hailstorm of June 18 had *no influence* on the barometer, which, from the 17th to the 19th inclusive, kept the whole day at a nearly constant height, 760 millimeters; and it had very little influence on the thermometer, which showed a difference of only four degrees between the temperature (23°) at the beginning and that at the end (19°) of the phenomenon.—*L. Godefroy, in La Nature.*

FIG. 1. FIG. 2. FIG. 3. FIG. 4. FIG. 5. FIG. 6. FIG. 7.

HAILSTONES WHICH FELL AT LA CHAPELLE-SAINT-MESMIN, FRANCE. (Natural Size.)

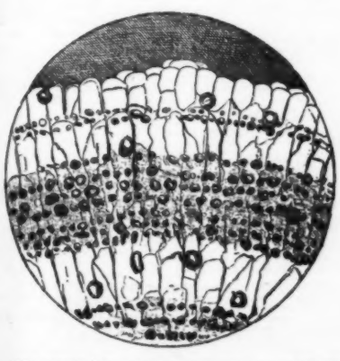


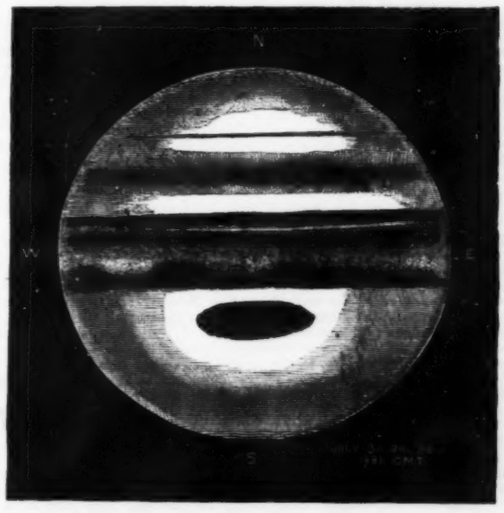
FIG. 8.—MAGNIFIED SECTION OF A HAILSTONE AS SEEN UNDER A POLARIZER.

THE RED SPOT IN JUPITER.

MR. E. E. BARNARD, of Nashville, Tenn., writing to the *English Mechanic*, under date of July 10, says:

The red spot has undergone little or no change since I saw it last in March. This morning it was well defined and decidedly deep in color—a reddish brown; there was a lightish space surrounding it for a distance equal to about half a breadth of the spot; this was very hard to see. The spot has not changed its position relative to the equatorial band, nor has it changed in form or size. I noticed that the spot was the deepest and strongest marked of any object on the planet, decidedly more distinct than the equatorial band.

To the north of the equator, where those mysterious black spots broke out during the latter part of last October, is a broad diffused reddish band. This belt is the result of the black spots, and is a light red in color. North of this is a thin linear belt, situated about midway from the north edge of the equatorial band to the pole; beyond this, a short distance, the north polar cap was faintly marked. There were several cloudy projections upon the inner edge of the south part of the equatorial band, while the northern band, as usual, was blended at its inner side, and a long lightish rift was observable near its northern edge.



THE RED SPOT IN JUPITER.

THE TIDAL EVOLUTION OF THE MOON.

Dr. Ball, Astronomer Royal for Ireland, lately delivered, in the Museum Buildings, Trinity College, Dublin, an interesting and instructive lecture on recent discoveries in astronomical science. Dr. Ball said that from the variety of topics which might fairly be dealt with in his lecture he would select three, and in making this selection he had been mainly guided by the relative importance of different astronomical problems. He had also endeavored to exercise his choice so that his lecture should, as far as possible, refer to the various branches of astronomy. Having dealt with two branches of this subject, Dr. Ball described "Darwin's Theory of the Tidal Evolution of the Moon." It had, he said, been the triumph of modern gravitational astronomers to indicate the changes which must be going forward in a system devoid of rigidity. It was at all events easy to show that the tendency of these changes lay in one direction, and this was the most important point for consideration. Every one was aware of the daily movements of the sea, which were called the tides. Most people were aware that the movements of the waters were caused by the attraction of the sun and the moon. Let them ponder, therefore, on the tides, as they seemed to give a clew to some of the profoundest of nature's secrets. He had heard that the port of Dublin was gradually being improved by the deepening of the bar. He had heard that the deepening of the bar had been attributed to the judicious action of the Port and Docks Board. But what the board had chiefly done was to call into requisition the scouring power of the tide, which, as he was informed, was gradually reducing or bearing away the bar. The tide was, therefore, accomplishing, at the bar of Dublin, the same kind of work as could be accomplished by men, or by steam-engines. In other words, the tide was here doing a useful work that could otherwise only be done by the expenditure of energy. It was the same elsewhere. The tides were doing work useful or the reverse, and expending energy in so doing. Where did the energy come from? It could not be created. It could only come from the store of energy available for such purposes in the solar system. The reserve energy whence the tides drew the supplies they were daily consuming consisted partly in the daily rotation of the earth on its axis. The earth was like a mighty fly-wheel which would absorb a prodigious amount of energy in setting it in motion, and which would give out that energy before it would be brought to rest. The rotation of the earth on its axis was a vast but not inexhaustible storehouse of energy, on which the tides could draw for thousands of years. Energy also existed in the solar system in many other forms, some of which could also be rendered available for the tides. So far as was known, the total amount of energy could not be increased. The important question was—Can that total ever be diminished? The tides were diminishing it every day. The small oceanic tides were not the sole source of the expenditure. The solid body of the earth itself must be subject to tides; still more must the fluid or gaseous members of our system be subjected to tides. All tides involved friction, and all friction involved loss of energy. Here, then, was the great discrepancy between the theory of Lagrange and the actual condition of our system. Lagrange's calculations assumed that the total energy of the solar system was constant, but the actual fact was that the energy was slowly diminishing. The tracing of tidal evolution was chiefly due to the labors of Mr. G. H. Darwin, son of the celebrated naturalist. The influence of the tides had already been recognized as the cause of the same face of the moon being always bent on the earth. Whether the tides were merely oceanic, or whether they were actual bodily tides, the results remained much the same. At the present time the moon revolved around the earth in a month; the earth revolved on its axis in a day. The tides produced in the earth by the moon must act to reduce the rate of the earth's rotation. The effect of the tides on the earth was to lengthen the day. The day was gradually lengthening, but this change could not take place without a reactionary change on the moon. The change undergone by the moon was perhaps a little difficult to understand, as it depended on some by no means simple dynamical principles. The friction of the tides consumed the energy of the system. It turned a large portion of that energy into heat, which was then radiated off into space to be for ever lost. But the friction of the tides could not alter the moment of momentum of the system. As the earth became gradually slower and slower in its rotation its moment of momentum decreased, yet for this to happen the moment of momentum of the moon should increase. It followed mathematically that as the tides gradually made the earth rotate more and more slowly, the moon must be getting farther and farther away from us. At the end of a million years from the present time the day will be more than one day of twenty-four hours is now; and in one million years hence the moon will move round the earth at a greater distance than she does now, and the length of the month will be correspondingly increased. In the far distant future, therefore, we are to look for an increased length of month. The length of day will, however, increase much faster than the length of the month, until at length the duration of the day equals that of the month. When this time arrives the moon will have moved out to a distance half as great again as it is at present, and the length of the month will have increased to two months. Our day will then have increased from twenty-four hours up to nearly two months, and as the moon continues to show the same face to us, we are destined to turn the same face on the moon. Were the earth and the moon the only bodies in the universe, such a state of things might go on for ever. The sun, however, will produce tides in the earth which will again modify their movements. He had said that the moon was gradually receding farther and farther from the earth, and that the length of the day was increasing—getting gradually longer and longer. But how long has this been going on? Yesterday was shorter than to-day. The day which Homer had was shorter than our day, but not indeed to any appreciable extent. There can be no doubt, however, that a million years ago the day was appreciably shorter than the day is at present. He wished to conduct them back to an exceedingly remote period, to a critical epoch in the history of the earth. That epoch must have been more than fifty millions of years ago, but how much more he could not tell. At that extremely remote time the day was greatly less than it is at present. It was only, indeed, a fraction of its present amount, being only from two to four hours long. He would trace back the moon to the same remote epoch to which he had conducted the earth. The tides in the earth are forcing the moon gradually away from us at present. The moon was, therefore, formerly nearer to us than it is now. Millions of years ago the orbit of the moon was much less than it is at present. The time of the moon's revolution was much smaller and the moon must have been quite close to the earth, and whirled round the latter in a period of from two to four hours equal to the period of the earth's revolution on its axis. Such, then, is the primeval condition of things to which the tracing of tidal evolution conducted. Antecedent to this critical epoch they could hardly go with any degree of certainty. After explaining Darwin's theory in reference as to the supposed rupture of the earth at a very remote period of time, and the consequent formation of the moon, the lecturer proceeded to speak of the surprise with which astronomers realized that the small interior satellite of Mars revolved on its axis in less than a third of the time—nearly twenty-four hours—which the primary occupied in revolving on its own axis. He also spoke of the tremendous forces in action at remote periods when tides rose to a height of a thousand or two thousand feet, scouring rocks and carrying enormous quantities of matter to the sea, and when that action caused so much comparatively rapid manufacture of strata.

THE BATTLE OF THE TRAPS.

One of the questions which the recent lectures by Mr. Hellyer on plumbing have reopened concerns the relative claims of the siphon and the ᗡ-trap. We have long doubted whether these ingenious expedients have the real worth plumbers of the old school credited them with, and since recent revelations and the discussions upon them which have taken place, we are surprised to find plumbers still quarreling over the merits of certain forms of traps.

Traps have undergone every conceivable modification in form since their introduction, and there are still in the market objectionable types. A good water-trap is one which will for the longest period insure an unbroken water-seal and which every flush makes clean. There should be no abrupt change in the direction of the flow, no sharp edges, and very quick bends are found less desirable than flatter ones. A water seal, one authority says, ought not to be less than ¾ inch, nor more than 1½ inch, and 1 inch is the usual depth of closet trap seals. Generally easy bends are better than deep traps, and more likely to allow of an easy passage of matter through them. But the advocates of both the two principal types of trap, the ᗡ and the ᔕ, have assumed a certain amount of ignorance on the part of the public and the profession, and the battle has been waged almost exclusively by patentees.

It is generally admitted that all traps are liable to "waving out" or siphonage if not ventilated, and the remarks of Mr. Emptage, of Margate, corroborate the opinion generally received, that both the ᔕ and ᗡ-traps require ventilation, though the latter and the V hold their seals more tenaciously. With regard to self-cleansing qualities, Mr. P. J. Davies has, to a certain extent, disproved the alleged non-cleansing property of the ᗡ-trap by the experiment he made with pebbles, though the form he exhibited and that generally used are somewhat different. It has been established, however, by general consent, that the siphon-trap, despite its demerits in the matter of siphonage, is the more scientific form for self-cleansing, and the profession will learn, probably with some astonishment, that even its predecessor can be made to perform the function quite as well. There are, however, ᗡ-traps *and* ᗡ-traps, and it would be of some importance if the profession would decide what form and proportion of this trap are safe. Mr. Davies has, by his graphical method of striking out the form of trap he recommends, endeavored to solve this problem, and we refer our readers to his demonstration.

The two main considerations on which the advocates of the rival traps base their claims are, first, with regard to siphonage, and second, to cleanliness. No one doubts that the ᗡ-trap is more secure as regards the first condition; the very form of the water-seal renders "waving-out" less easy; but we venture to think the best test of the second quality is the experience gained of two kinds in actual use. The majority of those who took part in the discussion were practical men, and they have probably seen what many who have had any experience of sanitary work have witnessed—a gradual fouling up of the ᗡ-trap, owing to the flow of water not coming in contact with the upper part of the trap. As might be expected, also, the square corners become filled with gas, and promotes corrosion of the lead, a point mentioned by Mr. Buchan.

The quantity of water held by a ᗡ-trap is undoubtedly greater than the quantity held by a siphon, and this is a point which, to our minds, would have much to do with the cleanliness of the trap. Mr. Davies has, it appears, tested this point, and finds that less water was contained in *his* form of ᗡ-trap than in the siphon, or than in the 9 in. ᗡ-trap; but of course the question of form and size has much to do with the matter, as well as with the force of water required to cleanse a trap efficiently. Practical points of connection with the soil-pipe have operated in favor of retaining the old-fashioned ᗡ-trap; but we are sure that of the two forms it must gradually give way either to a modification, as proposed by Mr. Davies, or to the ventilated siphon arrangement.

The remedy for "unsiphoning" a trap is to introduce an inlet at the highest point of the bend, and connect it with a soil or air-pipe, so that when a falling column of water induces suction behind it, the vacuum may be instantly filled up and the water-seal spared. With proper care, therefore, in ventiliating arrangements, the trap may be made independent of the risk of siphonage and a check of secondary importance established, while the ingenuity of inventors might be more profitably turned to the object of perfecting the flow and self-cleansing qualities of these appliances. We have already hinted that their efficiency depends much on the direction of the inlet and outlet, or, in other words, the contour of the trap. The ᗡ-traps still retain much of their old objectionable form, though some patentees have endeavored to make them more perfect by doing away with corners which obstruct solid matters and produce fouling at those parts. Mr. Davies's improvements and Mr. Hellyer's patent V-dip or "anti-ᗡ-trap" are steps in the right direction. There are no corners to become clogged up, and the water is made to exercise a scouring action upon the bottom. The seal is 1¼ in. The discussion which has taken place lately in our own pages on the relative merits of the two rival forms of trap has at least indicated a desire on the part of the advocates of both kinds to perfect them, while it has also shown that with proper precautions each kind of trap can be made efficient. Even the much-praised siphon is not always constructed with due care to its efficiency. We have seen, indeed, sudden bends and deep water-seals which would make it difficult for anything to pass through. In others the fault has been an easy bend and a quick fall, the effect of which is that the momentum of the flush would drive out the water entirely, and unseal the trap. Unfortunately, however, these sanitary controversies savor too much of the *odium theologicum* spirit. A blind partisanship sees nothing but perfection in a certain appliance, and any desire for improvement is often frustrated by the attempt to force the competing claims of the other side.—*Building News.*

BLACK BY DAY AND WHITE AT NIGHT.

Dr. Phipson describes a gate-post that had been painted white, which appeared black all day, but white every night. This was probably due to the phosphorescence of the barium sulphide which it contained. His analysis gave the following composition:

Barium sulphate	41·50
Barium sulphide	1·02
Protoxide iron	2·13
Oxide zinc	16·30
Sulphide zinc	37·44
Loss by calcining	1·62
	100·00

A catalogue, containing brief notices of many important scientific papers heretofore published in the Supplement, may be had gratis at this office.

THE
Scientific American Supplement.
PUBLISHED WEEKLY.
Terms of Subscription, $5 a Year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of The Supplement, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of The Supplement can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50, stitched in paper, or $3.50, bound in stiff covers.

Combined Rates.—One copy of Scientific American and one copy of Scientific American Supplement, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents, and canvassers.

MUNN & CO., Publishers,
37 Park Row, New York, N. Y.

TABLE OF CONTENTS.

PAGE

I. ENGINEERING AND MECHANICS.—Improved Vertical Boiler Plate Bending Rolls. 1 figure. 4807
The Quality of Steam. By John W. Hill, M.E. A Valuable practical paper read before the Providence Meeting of the American Railway Master Mechanics Association. 4809
A Novelty in Railway Construction.—The Darjeeling Tramway. 4809
Combined Road and Rail Truck Wheel. 2 figures. 4809
New Steam Line between New York and France. 4810
Improved Fifty-ton Testing Machine. 2 figures. 4810
The Influence of Surface Condition on the Strength of Steel. 2 figures. Tests of the strength of steel under variable surface conditions.—Tables. 4810
New Gas Burner. 1 figure. Marini & Gesler's Apparatus. 4811
Goodyear and McKay Sole Sewing Machines. Boot and shoe sewing machines.—Various machines for sewing leather. 4811
Büttcher's Gas Motors. 2 figures. 4812
The Battle of the Traps. Plumbing Problems. 4812

II. ART, ARCHÆOLOGY, ETC.—Suggestions in Decorative Art. 15 figures. Ornamental details in relief. By Prof. A. Brauszewetter, Bohemia. 4813
The Grave of William Penn. 1 figure. Penn's Grave and Old Quaker Meeting House at Jordans, Buckinghamshire. 4814
Important Archæological Discoveries in Assyria. 4815

III. PHYSICS, ETC.—On Spectroscopy. By Dr. L. Ciamician. 4816
Physics Without Apparatus. 1 figure. Lifting with fingers.—An electrical toy. 4816
Double Refraction. By A. Cornu. 4816
Microscopy. American Association Papers. 4816
The Condenser superseded. 4816

IV. CHEMISTRY, ETC.—Note on the Isolation of Strychnine. By Alfred H. Allen. 4817
Sodium and its Compounds. 4818
Ammonium and its Salts. 4818
Adulteration of Foods in France. 4819
Black by Day and White at Night. 4819

V. PHYSIOLOGY AND MEDICINE.—A New Current of Inductive Electricity, or a New Method of Producing Electrical Nerve and Muscle Reactions. By Dr. William J. Morton.—1 figure. 4817
Relation of Brain Power to the Weight of the Brain. 4817
New Flexible Stethoscope.—2 figures. 4817
The Treatment of Tetanus. 4817
Physiology of Visual Purple. 4818

VI. AGRICULTURE, ETC.—Butter Making. 4819
Fish and Fat Producers. 4819
Sweeny. 4819
Natural and Industrial History of the White Pine in Michigan. 4820
A Lifetime with Roses.—An address by Canon Hole, President of the National Rose Society of Great Britain. 4820

VII. METEOROLOGY AND ASTRONOMY.—A Remarkable Hailstorm in France.—6 figures.—Hailstones which fell at La Chapelle St. Mesmin. 4821
The Red Spot in Jupiter.—1 figure. 4821
The Tidal Evolution of the Moon. 4822

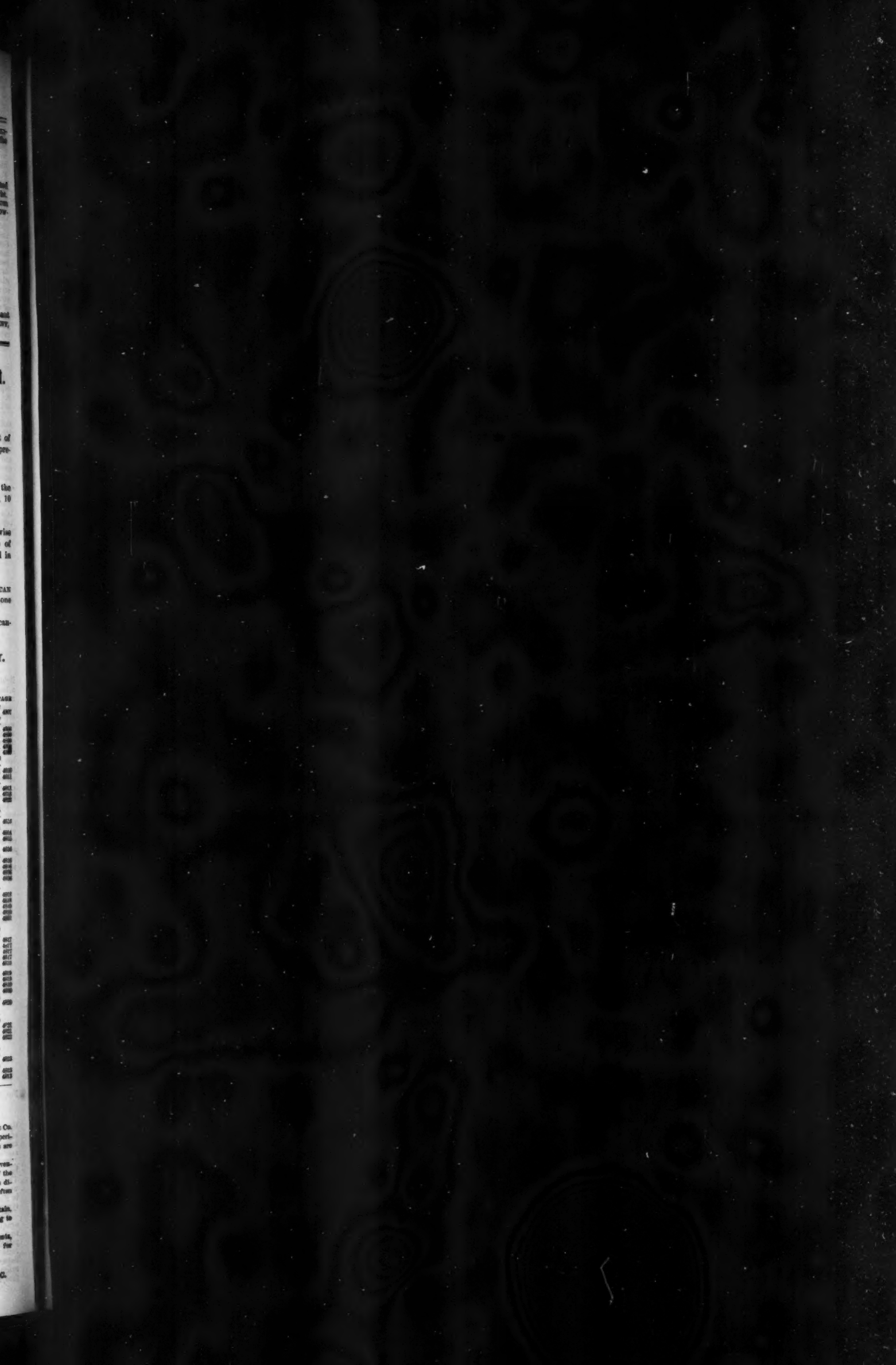
VIII. MISCELLANEOUS.—Operations of the British Post Office.—Letters.—Parcel post.—Telegraphs.—Telephones.—Savings banks. Postal orders.—Revenue. 4823
Center of Population in the United States in 1880.—Movement of population by decades since 1790. 4823
Public Instruction in the Province of Bologna, Italy. 4823

PATENTS.

In connection with the Scientific American, Messrs. Munn & Co. are Solicitors of American and Foreign Patents, have had 35 years' experience, and now have the largest establishment in the world. Patents are obtained on the best terms.

A special notice is made in the Scientific American of all Inventions patented through this Agency, with the name and residence of the Patentee. By the immense circulation thus given, public attention is directed to the merits of the new patent, and sales or introduction often easily effected.

Any person who has made a new discovery or invention can ascertain, free of charge, whether a patent can probably be obtained, by writing to Munn & Co.

We also send free our Hand Book about the Patent Laws, Patents, Caveats, Trade Marks, their costs, and how procured, with hints for procuring advances on inventions. Address

MUNN & CO., 37 Park Row, New York.
Branch Office, cor. F and 7th Sts., Washington, D. C.